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RADIO GUIDE
1934

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W. K.

FOREWORD

THIS year's "Radio Guide"—the seventh edition—sets a new standard as a manual of home construction, and we present it to readers fully confident that it will be voted the best yet. The book has been thoroughly overhauled, and the scope widened considerably. No attempt has been made to outline the theory of radio—in fact, such a task would be impossible in the limited space which could be devoted to this angle of the subject. Instead, the book has been written from a practical viewpoint throughout.

Last year five receivers were described; this year there are twelve. The sets featured comprise an exceptionally wide range of picked receivers, both t.r.f. and superhet, battery and a.c. operated, and for short-wave and broadcast band reception. The descriptions and diagrams are so complete and accurate that any constructor, whether beginner or "old hand," can set about building any of them with full confidence that his efforts will be successful.

The Reference Section, which in the past has proved so invaluable to experimenters, has again been enlarged by the addition of new design charts and tables, and also includes the latest valve characteristics chart.

Finally, while every effort has been made to solve the most common practical difficulties which crop up in home construction, it would be impossible to cover them all, and so readers are reminded that at all times a free information service is available to them through the "Questions and Answers" columns of both the "N.Z. Radio Times" and the "N.Z. Radio Record."

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What a saving of money and trouble! No more time wasted in selecting parts from dealer after dealer; no more trouble in planning and drilling the chassis; no more time and money wasted by the failure of second-rate components. Buy complete kit sets of standard advertised components, tested, matched and guaranteed, complete with circuit and wiring diagrams, ready for immediate assembly.

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It's the hidden built-in qualities in Tung-Sol Radio Valves that give such months and months of flawless performance. The long life you get from Tung-sol Valves is the result of years of experience, the use of processes and precision methods of manufacture that are unique in the radio industry.

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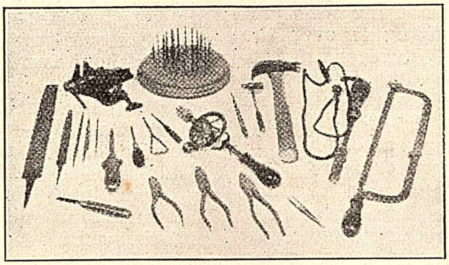
Introduction.

SMOOTHING THE BEGINNER'S PATH

REQUIREMENTS FOR A RADIO TOOL-BOX.

Building radio receivers is one of the finest of hobbies, but until the beginner has had a little practical experience, he will encounter many little difficulties which can be very discouraging. Usually they are so simple that in years to come he will be amused to recall that they once worried him, but nevertheless at the time they are real enough. This introduction is intended to assist the newcomer to radio by anticipating the commonest of these troubles and solving them for him, and so it should be read carefully and the various hints given kept in mind.



Though all these tools are not essential for building radio sets, they will be found useful.

First of all—tools. Just what are required for radio work? This question, like most dealing with radio, is difficult to answer in as many words. There is practically no end to the tools which *can* be bought, and which at some time or other will be found useful. At the same time, to build a kit-set, only a pair of pliers, a screw-driver, and a soldering iron are required.

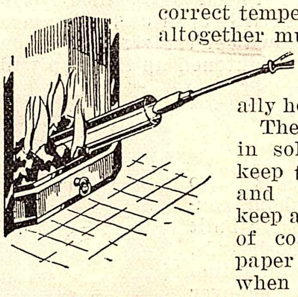
However, here are the tools that will be found in the average experimenter's kit. Incidentally, most of them will be found in the household tool-box. Soldering iron (preferably electric); tin of flux and rosin core (NOT acid core), solder; long and blunt-nosed pliers; side cutters; hand-drill (with an assortment of about half a dozen hardened steel bits, ranging in size from ⅛in. to ½in.); steel rule (graduated in inches and centimetres); reamer (to enlarge holes up to an inch in diameter); flat and three-cornered files; pocket knife (Boy Scout type); screw-drivers (large and small); hammer; and vice (small 4in. size is suitable).

With these tools it is possible to build every receiver described in this handbook. Others which will be found useful at times are a circle cutter, to cut holes in an aluminium chassis for mounting coils, valve sockets, etc.; centre punch; scriber; tweezers; square; and finally a small tap holder, a die-holder, and three or four taps and dies covering the 6-32, 8-32, and 10-32 sizes. With the dies brass rods can be threaded and cross threads run over, while with the taps, holes can be threaded so that they will take machine screws to bolt down components.

THE ART OF SOLDERNG.

The beginner is often dismayed at the prospect of using a soldering iron. In reality, his most difficult task is to overcome his diffidence, for soldering is an absurdly simple process if several easily remembered rules are kept in mind.

If mains power is available, an electric soldering iron of good quality should always be chosen in preference to any other. This type of iron is trouble-free, clean to work with, automatically maintains the correct temperature, and is altogether much more convenient than the externally heated type.

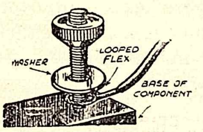


The golden rule in soldering is to keep the iron clean and hot. Always keep a file or a piece of coarse emery paper handy, and when the iron tip becomes dirty, a few rubs with either will restore its brightness. Tinning the soldering iron is done by filing the point bright and clean, dipping it in flux, and then rubbing it in hot solder until the point is covered with it. Surfaces to be soldered should also be scraped clean beforehand, and a suspicion of flux—not too much—applied to them before soldering. In this way a clean, sound and permanent joint will result. Never use any other than rosin core solder, as acid fluxes or soldering pastes cause corrosion of electrical connections.

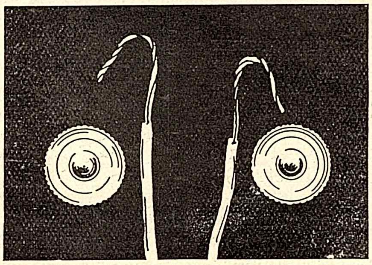
If the iron has to be heated in a coal or wood fire, then a simple and effective method of keeping the iron clean is shown in the sketch on page 7. A 5in. or 6in. length of brass or iron tubing, with an internal diameter slightly larger than the diameter of the soldering iron, is placed in the fire as shown, and the iron heated inside it.

MAKING CONNECTIONS TO TERMINALS.

When wiring up components provided with terminals, slip a solder tag over each shank and make the connection to that. The head can be screwed down much more tightly than if the alternative method of connection—that of looping the end of the wire and slipping it over the shank—is employed. However, if this method is preferred, it is always best to slip a washer over the shank on top of the loop before the terminal is tightened up, as shown in the sketch above. If two or more wires are to be connected to the same terminal, then a washer should be slipped over after each. This method of making connections will be found particularly useful when connecting flex leads of a battery cable to terminals.



When making connections to aerial or earth terminals, remember that there is a right and wrong way of doing it. The correct and incorrect methods are illustrated below. The wire placed near the left-hand terminal is incorrect, because when the terminal head is tightened down, the loop of wire will open out. The correct way is shown on the right. When the terminal is tightened up the loop will tighten also.

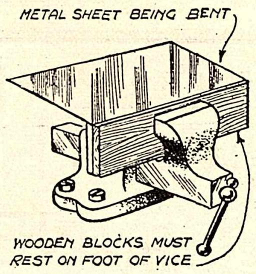


Left, incorrect, and right, correct, ways of attaching a wire to a terminal

PREPARING A CHASSIS.

A few years ago nearly all home-constructed sets were built on wooden baseboards. Nowadays an aluminium chassis with turned-over edges is almost invariably used, as it not only simplifies construction and wiring, but it permits of a much more compact layout, because many of the componets can be mounted underneath.

Unless the constructor has the requisite tools on hand for stamping and bending his own chassis, it is always best to purchase one ready stamped and drilled according to the layout diagram always published with set descriptions. Aluminium is not the easiest of metals to work unless the proper tools are at hand.



However, those who prefer to make their own will appreciate the following hints: The simplest way to make a neat straight bend in a metal sheet is to place it between two blocks of wood in a vice, and then make the bend as shown in the above sketch, first scoring a line deeply along the outside. When the four sides have been bent down, the chassis can be strengthened by means of angle brackets bolted inside each corner, though usually it will be rigid enough for the purpose without further strengthening.

Large holes for valve sockets, coils, etc., can be drilled at home in one of three ways. The first is to mark out the required circle and then drill round it just inside the circumference, with a small drill, making a complete circle of small holes touching one another. Then punch out the centre piece and trim the hole so made to an even circle with a pocket knife.

Secondly, a wood bit of the requisite size can be bought, and the blade tip cut off.

Thirdly, a simple tool can be made as follows, to cut large diameter holes. Obtain a piece of hard wood, about $\frac{3}{4}$in. square and about 4in. long. Screw a $\frac{3}{4}$in. iron wood screw into this, $\frac{1}{2}$in. from one end. Another screw should now be put in at a distance from the other equal to the radius of the circle required. It will be seen from the sketch on page 10 that the screws are put in up to the end of the threads. The heads should now be cut or filed off, and the second screw filed to form a slanting chisel point.

The way to use the tool is obvious. A centre hole is drilled in the chassis to take the centre screw, and the cutter is rotated about this until the metal is cut half-

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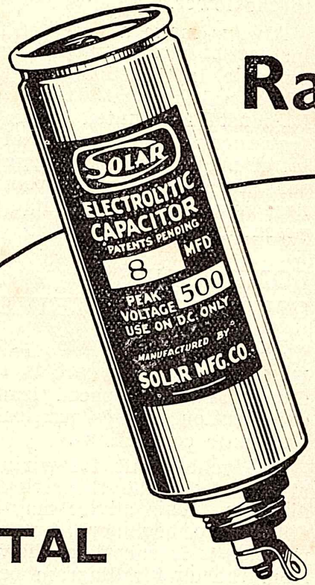

The illustration shows the SOLAR Wet Electrolytic, a condenser of marvellous capacity, although only measuring 4 3-8 inches by 1 3-8 inches. Other Solar Condensers obtainable are the Solar Dry Electrolytic and the Solar Sealdtite tubular type.

INSTAL

SOLAR condensers

Solar Condensers are made by the Solar Manufacturing Corporation, whose personnel has the benefit of constant acquaintance with every phase of engineering and production of fixed condensers since their earliest use in the radio industry. It is probable that no other active manufacturing group has continuously worked on these problems for as long a period.

Solar Condensers are genuinely non-inductive. They are very compact, have a full and well maintained capacity and an excellent power factor. Solar Condensers have an exceedingly long life. They will return to normal operation even after repeated voltage surges.

The manufacturers of many well-known radios have standardised on Solar. Play for safety when buying condensers and follow their lead.

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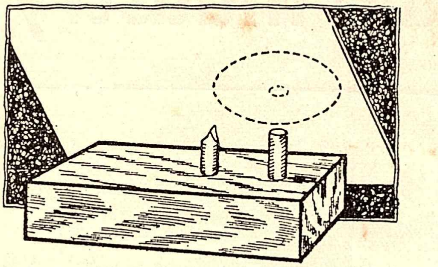
SOLAR

CONDENSERS

way through. Then reverse the chassis and repeat the process until the centre piece drops out.

Incidentally, for those who wish to try this method of preparing a chassis, the diameter of holes required for standard coils and valve sockets is 1¼in., and for intermediate frequency transformers and wet electrolytic condensers, ⅞in.



An easily-made tool for cutting holes in an aluminium chassis.

Two other standard diameters that will be found useful are those required for insulating bushes. The small size requires a ⅜in. hole, and the large a ½in. hole. Bushes are simple to mount if held with a reamer or three-cornered file while the lock-nut is being tightened up.

After small holes have been drilled in a chassis, the edges of the hole on the side where the drill emerges will be found to be rough, and with several sharp projecting points. These burrs can be easily taken out by placing the end of a larger size drill in the hole and rotating it several times.

POINTERS ON MOUNTING COMPONENTS.

The mounting of components is generally a straightforward task, but there are one or two small points worth mentioning.

Before bolting a condenser gang in position on a chassis, solder 6in. or 8in. leads to each section of the gang. Also, be sure to mount the gang far enough from the front of the chassis to permit the dial to be mounted in position.

Commercial coils should be mounted at least 2½in. between centres. There are several very important precautions to take when mounting electrolytic condensers, both of the wet and dry type. The wet variety either have a positive (red) and a negative (black) lead coming out from the can, or in other types the can itself form the negative terminal. With the former type the red lead should be connected to "B+" and the black to earth. while with the latter, the centre terminal is connected to "B+." The negative terminal ,i.e., the can itself,. is automatically earthed by being bolted to the chassis. Finally, wet electrolytics should always be mounted in a vertical position, with the terminal end downward. Just as much care should be observed when connecting up dry electrolytics to ensure that the polarity is correct. The end painted red, or the red lead, should be connected to the point of higher potential, and the other to the lower.

Always make a point of following the instructions for mounting components. For example, in the "1934 Crystal Amplifier" (described on page 39), the potentiometer R1 must be mounted before the power transformer, as the terminal board of the latter projects so far through the chassis that if this component were bolted down first, it would be impossible to mount the potentiometer.

SOME HINTS ON WIRING RECEIVERS.

The main rule to bear in mind when wiring up a set is to use short, direct, and well-spaced leads. The last qualification applies particularly to grid and plate connections.

The golden rule for wiring is to work always from the theoretical, or circuit, diagram. This advice may seem a little difficult to beginners, but with a little practice it is surprising how easy wiring from the circuit diagram becomes.

The values of fixed condensers and resistors are quite easily identified. The former have values marked on them, and the latter are colour coded. A system for marking values on fixed condensers which has become popular lately is to indicate their values, not in microfarads, but in micro-microfarads. In this way, a .00025 mfd. fixed condenser will be marked with the figure 250, and a .01 mfd. condenser with the figure 10,000.

Usually the first task when wiring an a.c. receiver is to connect up all the heaters, and in this connection it should be remembered that all leads carrying a.c., such as those to the heaters of all valves and to the plates of the rectifier, should be twisted to keep down hum.

Also, when connecting up a three-core flex to a power transformer, the following connections should be followed. The black wire should be connected to the solder lug usually marked "C" (common); the red wire to "220," "240," or "260" (usually "240") and the white or other colour to the nearest convenient earth point.

Finally, there are many sets in this handbook which can be built and put into operation by anyone capable of using a screw-driver, a soldering iron, and a little common sense. Of course, the larger and more complicated receivers are designed only for advanced experimenters, and it would be best for beginners to avoid these until they have mastered the rudiments of radio construction.

Section 1.

BUILDING BROADCAST BAND RECEIVERS

IN this section are described seven receivers for broadcast band operation, ranging from a simple crystal set to a seven-valve a.c. superheterodyne.

The choice of sets offered is particularly wide, but in the event of any constructor not finding just the receiver he wants to build, a list is given below of all the sets described in the "N.Z. Radio Times" during the past year. Back copies of this magazine are available from Box 1680, Wellington, price 1/1 posted. In each of the sets listed the type of receiver is indicated in parenthesis after the name.

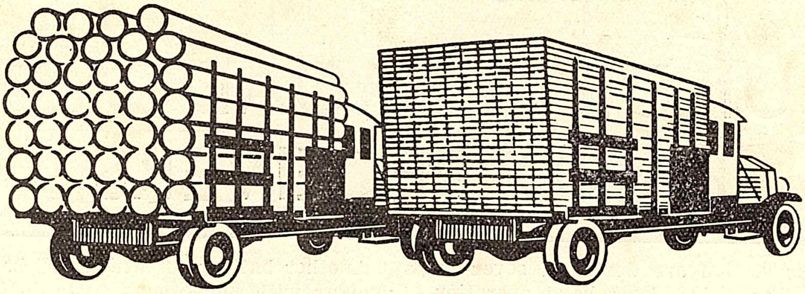
Of the sets now to be described, battery-set constructors will be interested in two outstanding designs, the "Conqueror Superhet" and the "Quality Five."

Another battery set which will be very popular with new-comers to radio is the "Tiny Tim" all-waver, a neat little one-valve receiver which covers not only the broadcast band but the short waves as well.

Prominent among the a.c. operated receivers is the "Super-Quality Six," a six-valve set designed primarily to give very high quality of reproduction. The "Elfin Four" is broadly speaking a similar set, though smaller. The section concludes with a description of the International" All-Wave Superhet, a Radiokes seven-valve kit-set which covers all bands, both short-wave and broadcast, at a turn of the wave-change switch.

"N.Z. RADIO TIMES" RECEIVERS DESCRIBED DURING THE PAST YEAR

"Big Ben Four" (a.c. all-wave, 58, 24, 56, 47)	April, '33
"1933 Night Hawk" (battery all-wave, 232, 233)	April, '33
Ultradyne Superheterodyne (a.c. superhet, 2-58's, 2-57's, 56, 59)	May, '33
"Skyline Five" (a.c.; t.r.f.; 2-58's, 57, 47)	June, '33
"Overseas Four" (battery t.r.f., 34, 30, 30, PM2)	June, '33
Telsen "Ajax Three" (t.r.f. battery kit-set)	July, '33
"De Luxe Band-Pass Seven" (a.c. t.r.f., 2-58's, 57, 56, 2-2A5's)	July, '33
"Selectra" Crystal Set	August, '33
"Sky King Six," I and II (battery superhet., 2-34's, 32, 2-30's, PM22A)	August, September, 33
"Eight Star Five" (a.c. superhet., 2-57's, 58, 2A5)	August, '33
Experimental Crystal Set	September, '33
"Modern Midget" (a.c. t.r.f., 58, 57, 2A5)	September, '33
"1933 Outspan Four" (battery t.r.f., 2-34's, 32, PM22A)	October, '33
"1933 Standard Superhet" (battery superhet, 2-34's, 77, 85, 2-PM22A's)	October, '33
"1933 Standard Superhet" (a.c. superhet, 2-58's, 57, 55, 2-2A5's)	November, '33
"Midget One" (battery one-valver, using type 30 valve)	November, '33
"Viking Shortwaver" (a.c. all-wave t.r.f. 58, 57, 56)	November, '33
"Superbe Superhet" (a.c. superhet, 2-58's, 2A7, 2B7, 2A5)	December, '33
"Explorer Shortwave Four" (battery all-wave, 2-32's, 2-30's)	December, '33
"Midgette Five" (a.c. superhet, 2-57's, 58, 2A5)	January, '34
"Tramper's One" (battery one-valver)	January, '34
"Midget Two" (battery two-valve, 2-30's)	January, '34
"Caesar's Ghost" (a.c. superhet, 2A7, 58, 2A6, 2A5)	February, '34
"Challenger Six," I and II	February, March, '34
"Compact Three" (a.c. local, 57, 2A5)	February, '34
"Midget Three" (battery t.r.f., 32, 2-30's)	March, '34
"International" Superhet (a.c. all-wave battery, 1A6, 2-34's, 32, 30, 19)	March, '34



Which carries most timber?

That load of poles bulks big. Yet there's more wood in the load on the right. Planks pack tight in compact layers.

Similarly round-cell batteries (or square cell built on round-cell principles) cannot possibly contain the power that's packed in a Columbia Layerbilt Battery. Round Cells mean waste space. Every available inch in a Columbia Layerbilt is crammed with energy-producing materials.

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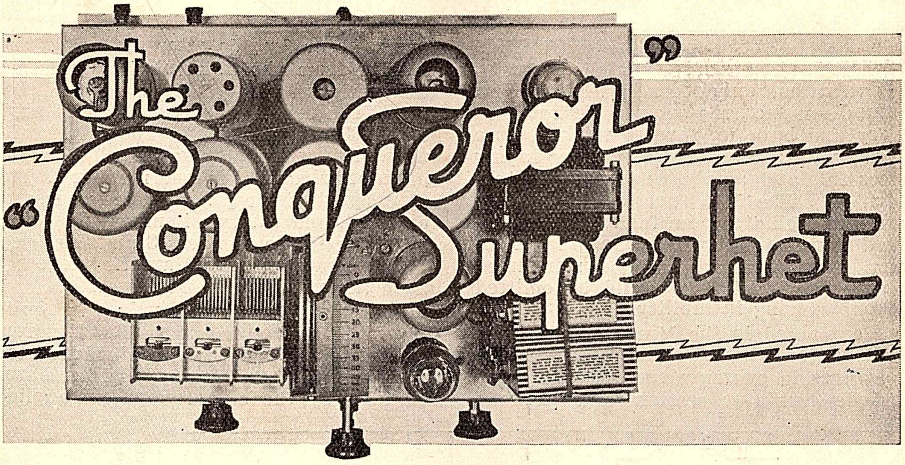
The "Conqueror" Superhet

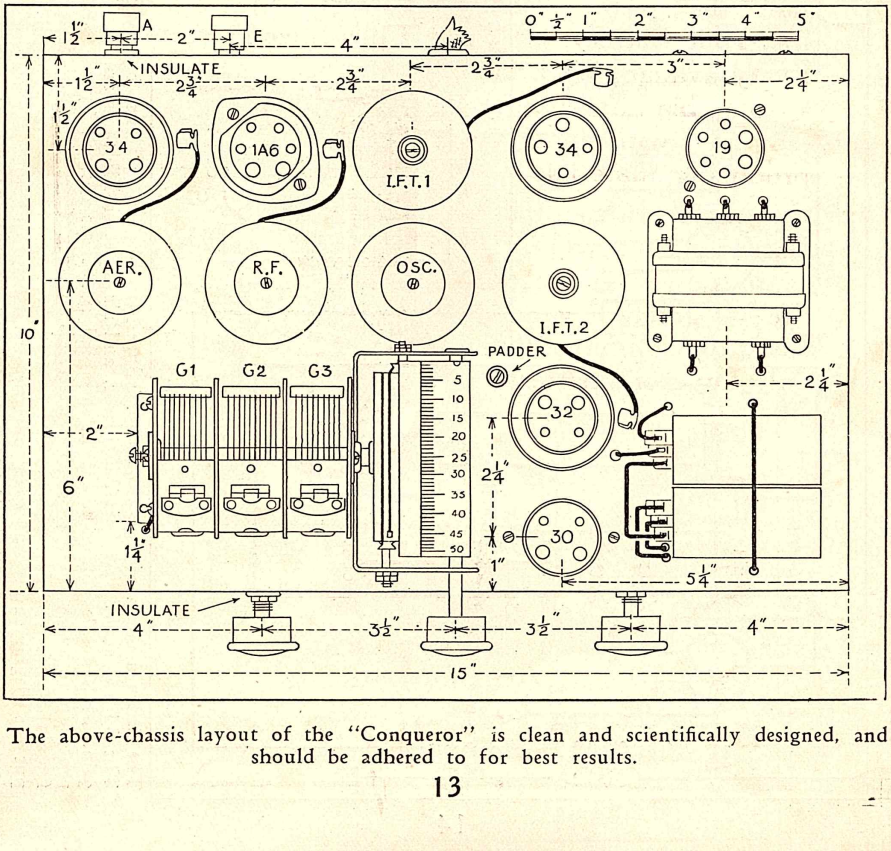


FOR sensitivity, selectivity, high tonal quality and general all-round performance, the "Conqueror" Superhet represents the last word in battery superheterodyne design. While this is a big claim to make, yet it has been amply substantiated by actual comparative tests. The tuning chart on page 15 shows the results of one evening's listening with this receiver. Every station listed was actually identified by call-sign. Many others were heard—quite a number of them at good volume—but as the calls were not picked up they were not included on the graph.

An Outstanding Circuit.

The circuit on the next page explains the splendid performance of the "Conqueror." Starting from the aerial, the first valve is a 34 multi-mu r.f. pentode, connected up as an r.f. amplifier.

The next valve is the 1A6—the valve around which the set was designed. It is the long-awaited combined mixer oscil-

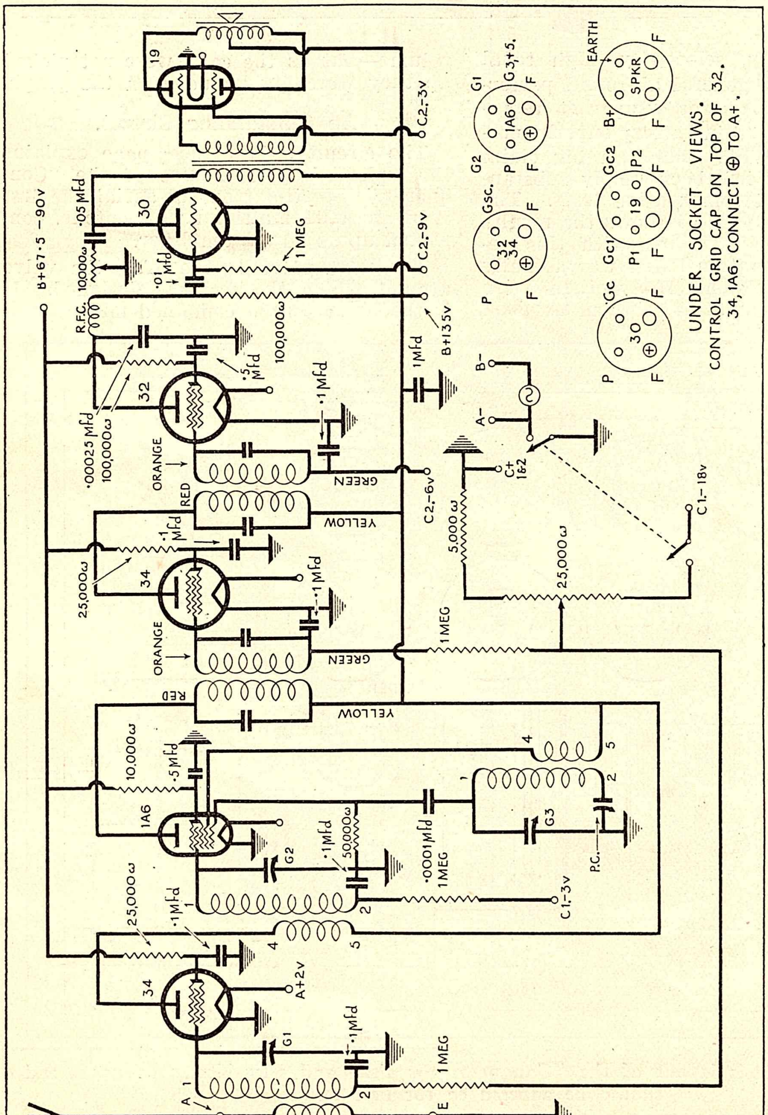


The above-chassis layout of the "Conqueror" is clean and scientifically designed, and should be adhered to for best results.

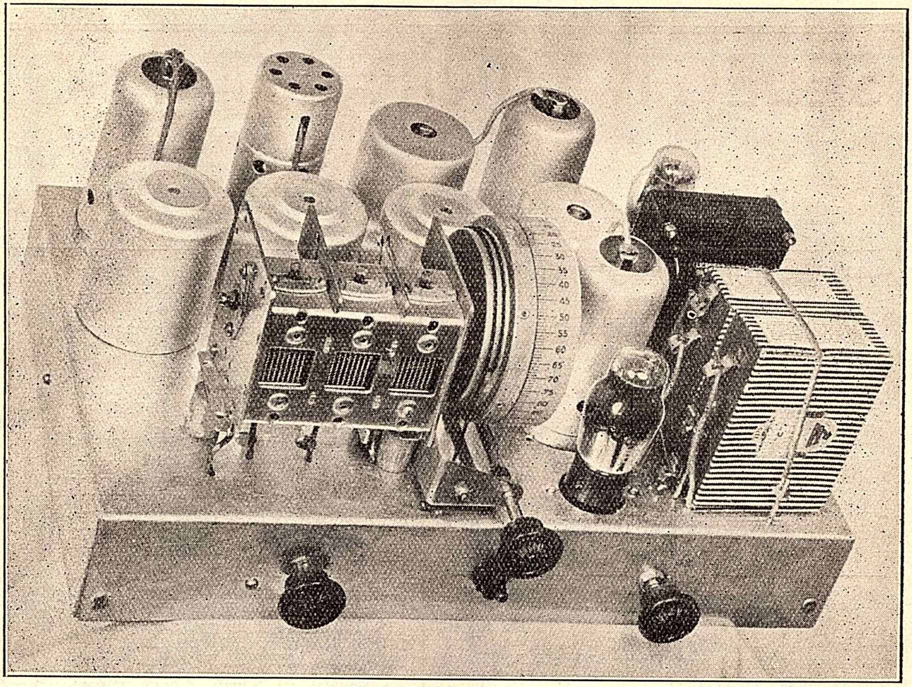
lator for battery operation—a function which it fulfills with very high efficiency. This valve has only recently reached New Zealand—in fact, the set was designed on theory and built up several weeks before it arrived. The initial tests were highly successful, and amply fulfilled every expectation. The 1A6 functioned perfectly as mixer-oscillator; in fact, the set behaved so well that it was found that additional filtering which had been included in the plate feed lines could be omitted without causing instability.

As explained in the March issue of the "N.Z. Radio Times," the 1A6 is really two valves in one envelope. It comprises a triode oscillator section and pentode modulator or first detector section. Commencing from the filament, the grids are numbered as follows. The first grid, i.e., that of the oscillator section, is grid number 1. That immediately above it is the anode grid, which acts as the plate of the oscillator triode. It is grid number 2. The control grid of the pentode section is grid number 4, and the two immediately below and above it are numbers 3 and 5 respectively. These two grids are tied together inside the valve.

The operation of the valve is quite simple. The electron stream flowing from filament to plate is first of all modulated by the oscillations of the local oscillator and then by the signal impulses applied



The circuit diagram of the "Conqueror" Superhet—one of the finest battery sets that has ever been described. The 34 r.f. stage, 1A6 mixer-oscillator, and air dielectric I.F. transformers used all combine to give tremendous gain, while ample volume and excellent tonal quality is ensured by the "B" class audio system. The best procedure to adopt when wiring the receiver is to work from the theoretical plan, and afterwards to check up from the under-chassis diagram. An even better way of checking, though it takes a little more time, is to put the diagram away and draw out the circuit according to the wiring. Then check the resulting circuit against the above, when any discrepencies will be immediately apparent.



How the "Conqueror" looks when complete.

to the control grid of the pentode section. The mixing thus takes place inside the valve. The resultant frequency, equal to the difference between the signal and oscillator frequencies, thus has the signal modulation impressed upon it before it is passed in the usual way to the primary of the first intermediate frequency transformer.

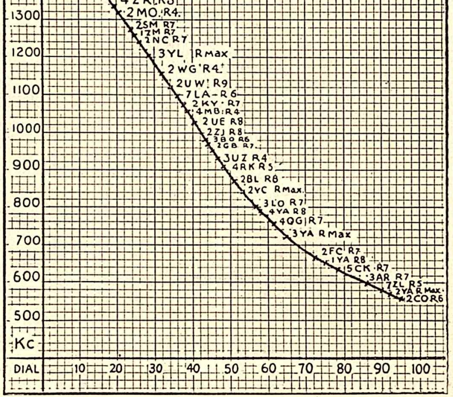
The next valve is another 34 multi-mu r.f. pentode, used as an intermediate frequency amplifier. It in turn is followed by a 32 screen-grid detector. Anode ben detection is used, because it will handle a much larger signal without distortion than the leaky grid type.

The latest air-dielectric intermediate frequency transformers are used because they represent a definite improvement over the mica-dielectric types in that they give greater gain and higher selectivity. In addition, they hold their adjustment accurately over much longer periods. The 32 is resistance capacity coupled to a 30 acting as a driver to a class "B" 19 valve, which comprises two triodes in one envelope. The very fine tone and surprising volume which this new system of audio amplification is capable of giving is too well known to need further stressing here.

Two Bias Batteries Used.

The biasing arrangements are interesting. Two bias batteries are employed, one for the r.f. and i.f. amplifiers and another for the detector and audio stages. This avoids the necessity for running long leads across the chassis, and no doubt is one reason for the good stability of the set.

Volume is controlled by the 25,000 ohm potentiometer connected in series with the 5,000 ohm resistor across "C1," an 18-volt "C" battery. The voltage so derived, which may be varied between 3 and 18 volts, is applied to the grids of the 34



This graph shows the stations actually logged with the "Conqueror" during one evening.

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	£	s.	d.
1—Chassis		7	6
1—Ebonite Panel and Back Sheet		5	0
1—Set four coils		12	0
1—3 plate Midget Condenser, Radiokes		2	0
1—.00015 Tuning Condenser		7	6
1—.00005 J.B. Semi-variable Condenser		1	6
1—50,000 Ohm Frost Potentiometer		3	6
1—4 Pin Marquis Socket		1	3
2—Wafer Sockets		1	0
1—Bulgin R. F. Choke		4	6
1—High Impedance Choke Radiokes type 3-10		15	6
1—Ormond Vernier Dial		3	6
2—Marquis Knobs		1	0
1—Sovereign 3 Point Switch		1	6
1—Pair S.T.C. Headphones		9	6
1—5 Wire Battery Cable		4	0
1—.0001 T.C.C. Type M Condenser			10
2—.00025 T.C.C. Type M. Condenser		1	8
1—.006 T.C.C. Type M Condenser		2	3
1—.1 T.C.C. Tubular Condenser		1	0
2—.5 T.C.C. Type Tubular Condenser		3	4
1—400 ohm Radiokes W/W Resistor		1	6
3—1 Watt Resistors 1/50,000, 1/1 meg, 1/4 meg		3	0
1—Set Raytheon Valves 1/32, 1/33	1	3	0
MISCELLANEOUS, exactly as shown in Guide Parts List		5	0

KIT OF PARTS **£6/0/0**

BATTERIES EXTRA:—

	£	s.	d.
3—2308 Burgess Batteries, each		18	6
1—2-volt 100 amp Solarc Accumulator	1	14	0

£4/5/0

THE VIKING JUNIOR.

	£	s.	d.
1—Chassis		7	6
1—Panel Ebonite with Back Shield		5	0
1—3-Plate Radiokes Midget Condenser		2	0
1—23-Plate Radiokes Midget Condenser		4	6
3—Ormond Dials 2/204A, 1/360	1	1	0
2—Wafer Sockets 1/6 pin, 1/5 pin		1	0
1—5-Pin Marquis Socket		1	3
3—Plug-in Coils		9	0
1—Radiokes 3-10 High Impedance Choke		15	6
1—20,000 ohm Frost Potentiometer		3	6
1—Bulgin S.W. R.F. Choke		4	6
1—30 Ohm Wearite Rheostat		3	0
1—58 Type Valve Shield		2	3
1 Pair S.T.C. Headphones		9	6
2—.0001 S.T.C. Condensers		2	0
1—.00025 T.C.C. Type M Condenser			10
1—.01 T.C.C. Type M Condenser		2	6
1—.5 T.C.C. Tubular Condenser		1	8
1—5 mfd Dulytic Condenser		3	6
4—1 Watt Resistors 1/4 meg, 1/100,000; 1/1 meg; 1/2000		4	0
1—Set Raytheon Valves 1/58, 1/56		18	3
MISCELLANEOUS, exactly as shown in Guide Parts List		14	6

KIT OF PARTS **£6/10/0**

THE CONQUEROR SUPERHET.

	£	s.	d.
1—Chassis		7	0
1—3-Gang Stromberg Carlson Condenser	1	5	0
1—Radiokes Drum Dial		12	6
1—Coil Kit with Padder	2	12	6
3—Shield Cans		4	6
1—Shield Can		2	3
7 Sockets 5/4 pin and 2/6 pin		3	6
1 Radiokes 3-7 B Class Input Transformer		14	0
1—10,000 Ohm Marquis Potentiometer		5	9
1—25,000 Ohm Frost Potentiometer		3	6
3—Marquis Knobs		1	6
1—Radiokes R.F. Choke		2	0
1—Alpha D.P.S.T. Switch		4	6
1—1 mfd. T.C.C. Tubular Condenser		2	6
3—.5 mfd. T.C.C. Tubular Condenser		3	4
6—.1 mfd. T.C.C. Tubular Condenser		6	0
1—.05 mfd. T.C.C. Tubular		1	0
1—.01 mfd. T.C.C. Tubular Condenser			10
2—.0001 mfd. T.C.C. Type M Condensers		1	8
11—1 Watt Resistors 4/1 meg; 2/.1 meg; 1/50,000; 2/25,000; 1/10,000; 1/5,000		11	0
1—Set Raytheon Valves 1/1A6; 2/34; 1/32; 1/30; 1/19	3	8	6
1—Amplion 03 B Class Speaker	3	0	0
MISCELLANEOUS, exactly as shown in Guide Parts List		11	3

KIT OF PARTS **£14/10/0**

(Continued on page 17)

F. J. W. FEAR & CO.

63 WILLIS STREET, Telegrams : "Fear" Wellington

OUR RANGE OF PARTS

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SPECIFIED BY THE "GUIDE"

BATTERIES EXTRA:—
1—18-volt C. Battery.
1—9-volt C Battery.
3—45-volt Burgess Batteries.
1—2-volt 100 amp. Accumulator

£4/15/0

EUROPE THREE.

	£	s.	d.
1—Chassis		7	6
1—2-Gang Stromberg Carlson Condenser		15	0
1—3-Plate Radiokes Midget Condenser		2	0
1—Set 8 Coils	1	4	0
4—Wafer Sockets 2/4 pin, 2/5 pin		2	0
2—Marquis Sockets 1/4 pin, 1/6 pin		2	6
2 Coil Shields		6	0
2—Valve Shields		4	6
1—S.W. Bulgin R.F. Choke		4	6
1—Igranic Jack		2	3
1—Plug		1	9
1—Amplion 03 Speaker, permanent Magnet	3	0	0
2—50,000 Frost Potentiometers ...		7	0
6—1 Watt Resistances 1/6 meg; 1/½ meg; 1/¼ meg; 1/50,000 ohms; 1/25,000 ohms; 1/5,000 ohms		6	0
1—2 mfd. 500-volt S.T.C. Condenser		4	0
4—.01 T.C.C. Tubular Condensers		3	4
2—.00025 T.C.C. Type M Condensers		1	8
1—.0002 T.C.C. Type M Condensers			10
1—.0001 T.C.C. Type M Condensers			10
1—Set Raytheon Valves 1/34, 1/32, 1/33	1	15	0
MISCELLANEOUS, exactly as shown in Guide Parts List..		8	0

KIT OF PARTS **£9/10/0**

BATTERIES EXTRA:—

	£	s.	d.
1—2-volt 100 amp. Solarc Accumulator	1	14	0
3—45-volt Burgess Standard Duty Batteries, each		18	6
1—F.O.P. G4 18-volt C Battery		4	6

£4/10/0 Net.

TINY TIM.

	£	s.	d.
1—Chassis		7	6
1—Ebonite Panel		3	0
1—.00035 Formo Condenser		5	9
1—Formo Vernier Dial		3	6
1—.0003 Graham Farish Bakelite Resistor		3	0
1—10 ohm Wearite Rheostat		3	0
2—Marquis Knobs		1	0
1—Tumbler Switch		1	3
1—4-Pin Wafer Socket			6
1—5-Pin Coil Socket		1	3
4—Coils Already Wound		12	6
2—.0002 T.C.C. Type M Condensers		1	8
1—4-Meg Grid Leak		1	0
1—Radiokes R.F. Choke		2	0
1—Phone Jack		2	3
1—Marquis Phone Plug		1	9
1—4-Wire Battery Cable		3	6
1—Pair S.T.C. Headphones		9	6
1—Raytheon 30 Valve		8	0
MISCELLANEOUS, exactly as shown in Guide Parts List..		3	6

KIT OF PARTS **£3/10/0**

BATTERIES EXTRA:—

	£	s.	d.
1—60-volt V1 Full o' Power Battery		12	0
1—2-volt 100 amp Solarc Accumulator	1	14	0

£2/2/6 Extra.

THE QUALITY FIVE.

	£	s.	d.
1—Chassis		7	6
1—3-gang Stromberg Carlson Condenser	1	5	0
1—Peter Pan Dial		5	9
1—Set Radiokes Coils	1	2	0
3—Valve Shields		4	6
6—Wafer Sockets 5/4 Pin 1/6 Pin		3	0
1—Radiokes B Class Transformer Type 3-7		14	0
1—50,000 ohm. Frost Potentiometer		3	6
1—.0003 Graham Farish Reaction Condenser		3	0
1—D.P.S.T. Alpha Switch		4	0
4—Marquis Knobs		2	0
1—Radiokes R.F. Choke		2	0
7—1 Watt Resistors 1/2 meg; 2/1 meg; 1/100,000; 2/25,000; 1/10,000		7	0
2—.00025 Type M.T.C.C. Condensers		1	8
4—.1 T.C.C. Tubulars		5	0
1—1mfd. T.C.C. Tubular		2	6
1—Set Raytheon Valves 2/34, 1/32, 1/30, 1/19	2	16	6
1—Amplion 03 Speaker B Class...	3	0	0
Miscellaneous Parts, exactly as Guide List		12	0

KIT OF PARTS **£11/5/0**
Postage Paid

BATTERIES EXTRA—

	£	s.	d.
3—45-volt Burgess 2308 Batteries, each		18	6
1—18-volt Full O' Power C Battery		4	6
1—2-volt 100 amp. Solarc Accumulator		34	0

EXTRA **£4/10/0**

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RADIOKES KIT, less Valves and Speaker	**£14/5/0**
Complete with Raytheon Valves and Jensen D16 Speaker	**£18/0/0**

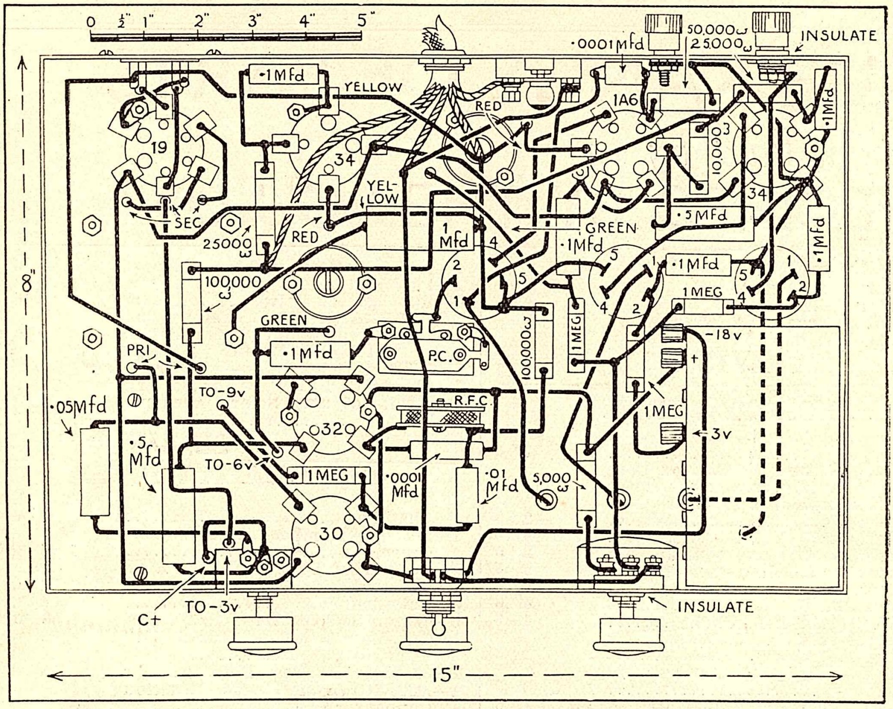
PUBLIC ADDRESS 12 WATT AMPLIFIER.

	£	s.	d.
1—Chassis Stamped and Drilled ..		10	6
1—Radiokes M5 Transformer	1	5	0
1—Ferranti AF5c Transformer ...	2	15	0
1—Stromberg Carlson 2-Gang Condenser		15	0
1—Dial with Lamp and Knob		8	0

(Continued on page 38)

F. J. W. FEAR & CO.

63 WILLIS STREET, Telegrams: "Fear" Wellington



The under-chassis diagram, showing the wiring. All leads should be kept short and as well spaced as possible.

multi-mu r.f. and i.f. amplifiers, and so provides an effective control of volume. The 5,000 ohm limit bias resistor ensures that there will always be a minimum bias of —3 volts on these two valves.

A double-pole single-throw on off switch is employed to break both the circuit of "C1" and the "A" and "B" circuit when the set is off. Otherwise, the slight current drain from "C1" through the potentiometer and limit bias resistor would appreciably shorten the life of this battery.

A fixed bias of —3 volts is applied to the grid of the pentode section of the 1A6 modulator. A bias of —6 volts is required for the 32 anode bend detector, and this is supplied from the second "C" battery. The bias on the type 30 driver is —9 volts, which reduces the plate current of this valve as far as possible without introducing distortion. Similarly, the 19 class "B" amplifier is given a bias of —3 volts, which also effects an appreciable saving in "B" current without endangering volume or tone.

A refinement which will be appreciated by dxers is the tone control incorporated in the plate circuit of the driver valve. Strictly speaking, from the point of view of tonal balance this control is not necessary, yet when DX conditions are bad, by setting the tone control potentiometer to reduce the high-note response, an appreciable amount of static and general mush is cut out.

Building The "Conqueror."

The photographs accompanying this article give a good idea of how the finished receiver looks. The layout (shown best in the above-chassis diagram) is definitely the best to adopt, and no departure should be made from it under any circumstances.

After the components detailed in the list of parts have all been assembled, the constructional work can be commenced. First of all, mount the valve sockets and shield bases, being careful to arrange the filament pins in the directions shown in the above-chassis diagram. Now drill the holes for mounting the gang and padding condenser, not forgetting the three holes required to permit the trimmers, which are under the gang, to be adjusted when the set is being aligned. Also drill the mounting holes for the padder, and then bolt the coils in position. The class "B" audio transformer can next be bolted down, and after this the chassis should be reversed and the wiring commenced.

Make a start with the valve sockets, wiring the filaments first of all. The under-socket connections of every valve used are shown in the circuit diagram. Notice that the left hand filament pin of each of the 34's, 32, 1A6, and 30 should be made the positive one. Each of the negative pins is connected to earth by soldering it to a tag placed under the nearest bolt holding the socket in position.

The remainder of the wiring can now be proceeded with as far as possible. Be careful to leave room for "C1"—the bias battery for the r.f. and i.f. valves. The colour coding of the various coils is shown on the circuit and under-chassis diagrams. The padding condenser, volume and tone control potentiometers, on/off switch, aerial and earth terminals and the battery cable bushing can also be mounted. Make sure that the shaft of the volume control potentiometer and also the aerial terminal are insulated from the chassis by means of bakelite washers or bushes.

Next, solder a 6-inch lead to each of the lower solder tags. Then mount the drum dial on the gang, as detailed in the carton accompanying it, and finally mount the entire gang and dial in position. The two "C" batteries can next be fastened in place.

At this stage, it is advisable to check over the complete wiring from both the theoretical and layout diagrams.

Now solder on the four grid caps, fit the control knobs, and plug in the valves and speaker. Screw the 60 m.a. fuse bulb into its holder and connect up the "A" battery. Then switch on, and by looking down directly on the top of each valve, it should be possible to see the filaments glowing. If this is not the case, then switch off and check up the wiring.

Finally, when the "B" battery and aerial and earth are connected, the set is ready for lining up.

A Good Earth is Essential for Greatest Gain.

On the circuit diagram the screen voltage is indicated as "B+67.5 to 90 volts," and a word of caution is needed here before proceeding further. If it is desired to get the last ounce of gain from the set, the 90 volt tap may be used, but it is abso-

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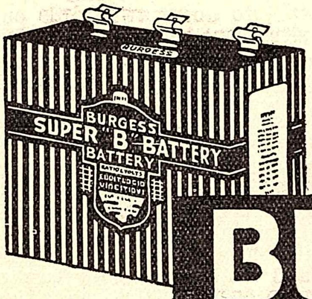

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List of Parts.

1—chassis, drilled and stamped as shown.
1—3 gang condenser (Radiokes).
1—drum dial, escutcheon, and 2v. pilot-light (if required) (Radiokes).
1—aerial coil, 1 r.f. coil, 1 oscillator coil (to suit 1A6) and padder (Radiokes. Lekmek).
2—175 k.c. air dielectric I.F. transformers (Radiokes, Lekmek).
3—type 224 valve shields.
1—type 58 valve shield, with cap.
5—4 pin wafer sockets (Renrade).
2—6 pin wafer sockets (Renrade).
1—class "B" input push-pull transformer (Ferranti, AF15C, or Radiokes).
1—10,000 ohm potentiometer (Marquis).
1—25,000 ohm potentiometer (Radiokes).
3—knobs (Marquis).
1—r.f. choke (Radiokes).
1—D.P.S.T. switch.

FIXED CONDENSERS.

1—1 mfd. pigtail type (T.C.C., Standard, or Solar).
2—.5 mfd. pigtail type (T.C.C., Standard, or Solar).
6—.1 mfd. pigtail type (T.C.C., Standard, or Solar).
1—.05 mfd. pigtail type (T.C.C., Standard, or Solar).
1—.01 mfd. pigtail type (T.C.C., Standard or Solar).
2—.001 mfd. mica (T.C.C., Standard, or Solar).

FIXED RESISTORS.

4—1 megohm carbon (Ohiohm).
2—100,000 ohm carbon (Ohiohm).
1—50,000 ohm carbon (Ohiohm).
2—25,000 ohm carbon (Ohiohm).
1—10,000 ohm carbon (Ohiohm).
1—5000 ohm carbon (Ohiohm).

VALVES.

1—1A6, 2—34, 1—32, 1—30 (or PM2A). 1—19 (Raytheon, Radiotron, National Union. Sylvania, Tungsol).

SPEAKER.

1—permanent magnet dynamic, with class "B" input transformer to match 19 valve (Magnavox, Jensen, Amplion).

BATTERIES.

3—45v. heavy duty "B" blocks (Columbia, Hellesen's, Full-O-Power, Burgess).
1—18v. "C" batt., with 3 wander plugs and mount (Full-O-Power, Burgess, Columbia, Hellesens).
1—9v. "C" batt., with 4 wander plugs and mount (Full-O-Power, Burgess, Columbia, Hellesens).
1—2v. 60 or 80 amp. hr. accumulator (Exide).

MISCELLANEOUS.

4—grid clips; 1 large and 2 small bushes; "A" and "E" terminals; 5 wire battery cable, with wander plugs; 60 m.a. fuse bulb and holder; 2½ doz. assorted nuts and bolts; 1½ doz. solder tags; 1 coil Henley push-back wire; 2 feet push-back flex.

lutely essential that the earth should be a highly efficient one. The lead should be short and direct, and well soldered to a metal pipe or object buried well down in damp ground.

The values of the screen feed resistors for the first three valves have been so calculated that with the common lead connected to the 90 volt tap, each screen will have exactly 67.5 volts on it, which is the optimum voltage for greatest gain from each of these valves. Nearly every other publication we have seen describing a set of this type has recommended that the screen voltage tap should never be increased above 67.5 volts, despite the fact that the screen feed resistors might be dropping as much as 20 volts, leaving roughly 50 volts available on the screens themselves. This procedure certainly reduces the risk of instability, but it also cuts down the gain of the set.

For this reason, if a good earth is available, then the 90 volt tap may be used, but otherwise the common lead should be connected to the 67.5 volt tap. We do not want constructors to think that the set is at all unstable with the full 67.5 volts on the screens of the first three valves, because this is definitely not so. In fact, r.f. chokes and .1 mfd. filter condensers were included in each plate feed line to the first three valves, but even with the common screen lead attached to the 90 volts tap, they were found to be unnecessary and so were taken out.

A suggestion here for those who want to get the last ounce out of this set, but who for some reason or other cannot instal an efficient earth, is to connect a 50,000 ohm wire-wound potentiometer between the 67.5 and the 90-volt taps, and connect the common screen lead to the moving arm terminal. In this way the maximum screen voltage without instability can be obtained.

Lining Up the Set.

When the dial is rotated for the first time it will probably be alive with repeat points, but accurate aligning will eliminate these.

As the trimmers are mounted underneath the gang, the set should be placed on a table so that the left-hand end of the set projects over the table. First of all, set the trimmer on the oscillator section of the gang, i.e., that nearest the drum dial, to about two-thirds out, and the padder about half-way out. Now tune in a station near the low frequency end of the dial, say 2YA, and turn the volume well down. Next adjust the padding condenser screw little by little until the volume is loudest, altering the dial setting if necessary for best results. Tentatively set the trimmers on the r.f. section of the gang for maximum response.

Now tune in a station near the high-frequency end of the dial and adjust the aerial and r.f. trimmers for best results. Now make ever so slight an adjustment of the trimmer of the oscillator section, "rocking" the dial a little while doing so to ascertain if the response increases. If it does, leave the oscillator trimmer at the new maximum response setting; otherwise, return to the former setting.

Now turn back to the station at the low frequency end of the dial once more, and again readjust the padder to test whether response can be improved. Work only on the padder this time, and leave the trimmer alone.

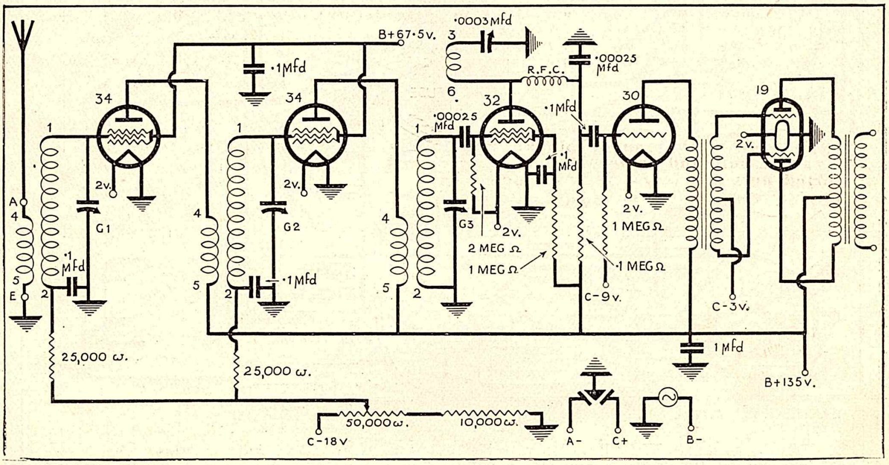
The "Quality" Five

JUST as the "Conqueror" superhet represents the latest in modern battery superheterodyne design, so the "Quality Five" is the last word in battery-operated sets of the tuned radio frequency type.

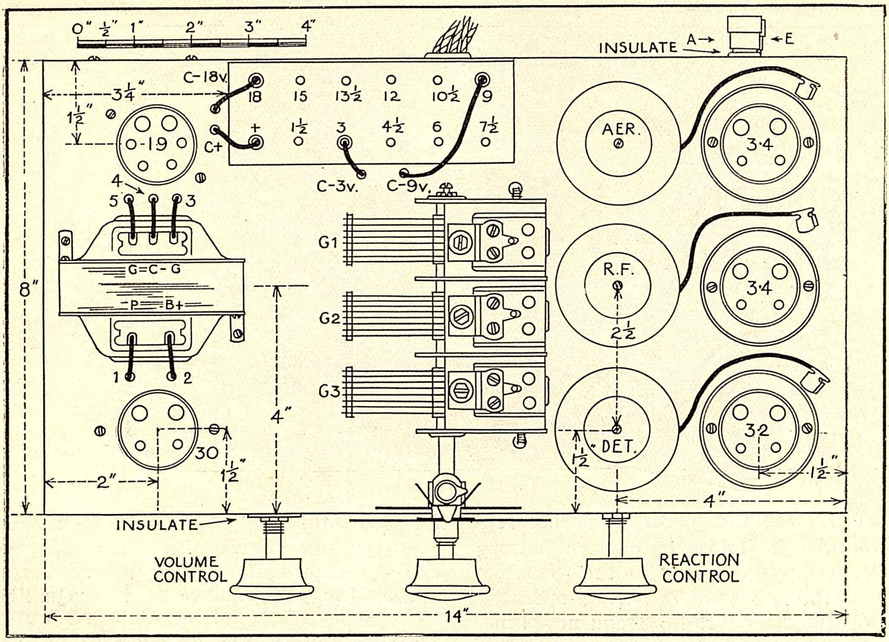
The sensitivity of the set is little short of amazing—during one evening's listening no less than 30 stations, including three Americans and four Japanese, were tuned in and definitely identified by call-signs. A number of others were also picked up, but the calls were not heard.

The tone, too, is excellent. With the introduction of the class "B" system of audio amplification, battery sets no longer labour under the handicap of limited volume and indifferent tone, and, valve for valve, this type of set is now capable of giving as fine results as an a.c. receiver. This statement is amply borne out by the performance of the "Quality Five," which can deliver almost 2 watts of output power, with a quality of reproduction comparing favourably with that of many a.c. receivers on the market.

The circuit is an improved and modernised version of that used in the most popular battery set ever described in the "Radio Times"—the "Outspan Four." In the "Quality Five," "B" class audio has been substituted for the single output pentode to provide more volume and better quality. However, the feature which was largely responsible for the success of the "Outspan"—the incorporation of re-action with ganged tuning—has been



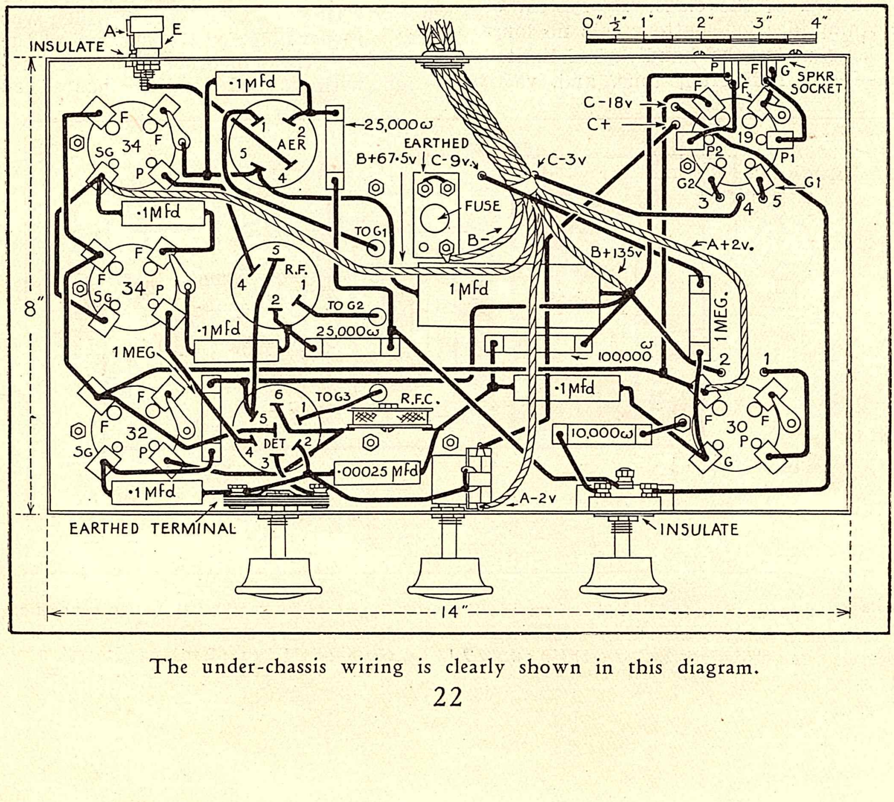
The circuit of the "Quality Five"—an up-to-date and more powerful version of the "Outspan Four," a receiver which is still widely popular.



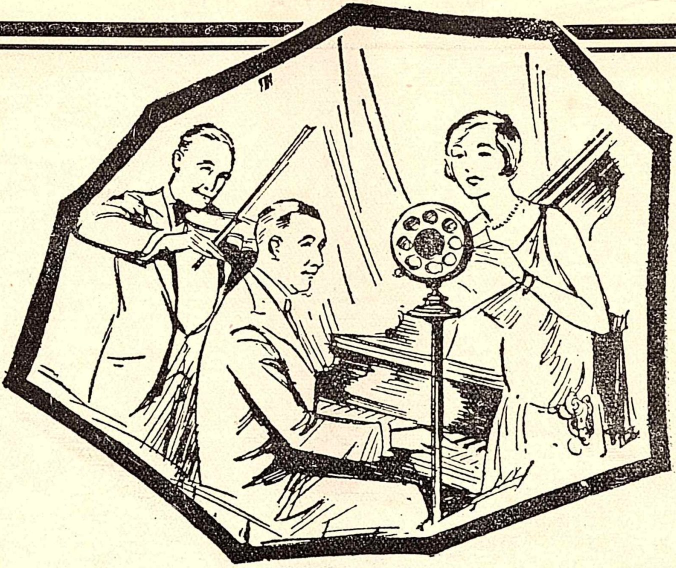
Dimensions for drilling and stamping the chassis are contained in this sketch.

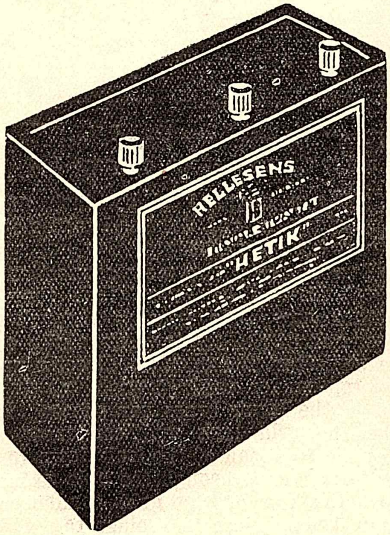
retained. Thus, as it is now over three years since the first "Outspan" was described, the "Quality Five" represents the outcome of three year's constant effort towards the ultimate in t.r.f. battery sets.

Volume is controlled by the 50,000 ohm. potentiometer connected in series with a 10,000 ohm. resistance across the 18-volt "C" battery. This potentiometer regulates the amount of bias applied to the grids of the type 34 multi-mu r.f. pentodes, and hence the amplification. The



The under-chassis wiring is clearly shown in this diagram.





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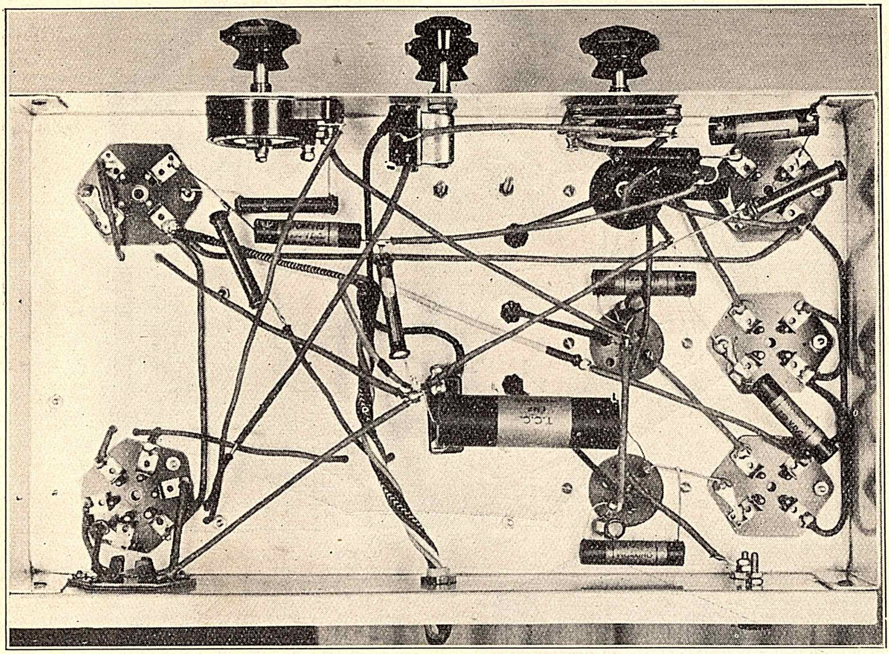

An under-chassis photograph of the "Quality Five," showing the simple, neat, and direct wiring. Compare this photo with the under-chassis diagram on page 22.

10,000 ohm limiting resistor ensures that there will always be a bias of —3 volts on these valves. As it is necessary to break the "C" battery circuit when the set is switched off, a three-point on/off switch is necessary. In the original model a rotary type double-pole single-throw switch was used, with the two inner terminals shorted together and earthed.

Building The Set.

The first task is to fit the grid-leak and condenser inside the detector coil in the manner now to be explained. This obviates the necessity of mounting these two components between the grid cap of the screen-grid detector valve and the lead coming out from the top of the detector coil can.

The operation is quite a simple one if the following procedure outlined is adhered to. First of all, take out the screw on the top of the detector coil and carefully withdraw the coil. In the Radiokes coil, the red flex lead which emerges from a hole in the side of the can is soldered to a tag on the top of the former. Carefully unsolder this lead and lay it aside.

Now remove the brass bar passing across the top of the former. Next, solder one lead from the grid leak to one from the grid condenser, first of all shortening these leads until the ends of the two components, when soldered together, are about half an inch apart. Now solder the red flex lead to the junction of these components.

There are only two more connections to make. It will be found that there is another brass bar passing through the lower end of the former. Carefully clear the wax from the opening directly under the top solder tag, through which the end of the lower brass bar passes. Now take the grid leak and condenser and pass the free lead of the leak down inside the former and through the hole so made, until the top of the grid condenser is about 1-8in. below the solder tag. Solder this lead to the end of the brass bar, cutting off any surplus. Next take the free lead of the grid condenser, pass the end through the rivet holding the top solder tag in place, solder it in position, once again cutting off the surplus.

Finally, carefully remove the screw in the bottom of the former, slip a solder tag over it, and replace it. The coil can now be put back in the can, the flex lead being taken out of the side as before. When the top screw has been replaced, the coil is once more complete. The solder tag in the centre of the coil base should be connected to "A+," as shown in the under-chassis diagram.

The next step in the construction is to mount all the valve sockets on the chassis. All filament holes face to the rear, as

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List of Parts.

1—chassis, drilled and stamped as shown.
1—3 gang condenser, with dial (and 2v. dial light if required) (Radiokes).
3—coils, 1 aerial, 1 r.f., 1 r.f. with reaction winding (Radiokes, Lekmek).
3—type 224 valve shields.
6—wafer sockets, 5—4 pin, 1—6 pin (Renrade).
1—class "B" input push-pull transformer (Radiokes).
1—50,000 ohm potentiometer, with insulating bush (Radiokes).
1—.0003 mfd. reaction condenser.
1—D.P.S.T. rotary switch.
4—hexagonal knobs, 1 small and 3 large (Marquis).
1—r.f. choke (Radiokes).

FIXED RESISTORS.
1—2 megohm resistor (Ohiohm).
2—1 megohm resistors (Ohiohm).
1—100,000 ohm resistor (Ohiohm).
2—25,000 ohm resistors (Ohiohm).
1—10,000 ohm resistor (Ohiohm).

FIXED CONDENSERS.
1—.00025 mfd. mica grid condenser (T.C.C., Standard, or Solar).
1—.00025 mfd. pigtail type (T.C.C., Standard, or Solar).
5—.1 mfd. pigtail type (T.C.C., Standard, or Solar).
1—1 mfd. pigtail type (T.C.C., Standard, or Solar).

VALVES.

2—34; 1—32; 1—30 (or PM2A); 1—19 (Raytheon, National Union, Radiotron, Sylvania, Tungsol).

SPEAKER.

Permanent magnet dynamic, with class "B" input transformer to match type 19 valve, and with cord and UX plug (Magnavox, Amplion, Jensen).

BATTERIES.

3—45v. "B" blocks, heavy duty (Columbia, Hellesens, Full-O-Power, Burgess).
1—18v. "C" battery (Columbia, Hellesens, Full-O-Power, Burgess).
1—2v. 80 amp. hour accumulator (Exide).

MISCELLANEOUS.

60 m.a. fuse and holder; "A" and "E" terminals; 1 large and 1 small bush; 5 wire battery cable, with wander plugs; aluminium base for mounting "C" battery (5¼in. x 2in. x ½in.); 2 doz. assorted nuts and bolts; 1 doz. solder tags; 1 coil Henley push-back wire; 4 "C" battery wander plugs; 3 grid clips; 3 feet flex for bias battery leads.

shown in the under-chassis diagram. The coils should be mounted next, followed by the gang. Before mounting the latter component, attach three leads, each four inches long, to the lower tags, to go through the holes beneath the gang to the appropriate terminals on the coils.

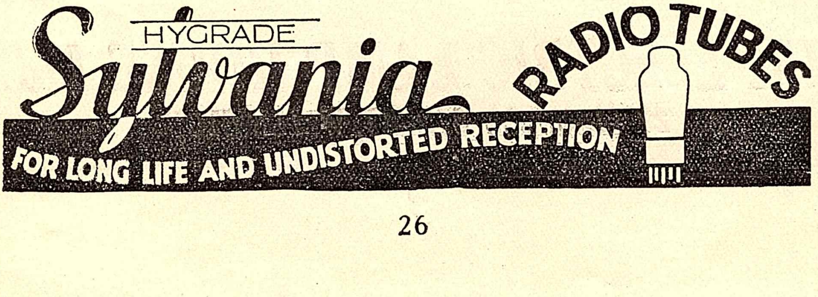
Next mount the audio transformer in the position shown, and then the battery cable bush, the aerial and earth terminals, the aluminium box to hold the bias battery in place, the volume control potentiometer, and the reaction condenser. Of these components, be careful to insulate the aerial terminal by means of a small bush from the chassis, and also the volume control potentiometer with the bakelite washers provided, or with a bush. Finally, the double-pole single-throw on/off switch can be mounted in position.

Now turn the chassis over. The only components to mount here are the fuse-holder and the four-pin speaker socket When these are in position, the wiring may be commenced. Complete the filament wiring first of all. One filament pin of each valve is connected to earth by soldering to it a tag mounted under the handiest bolt holding the socket in position. The remaining filament terminals are all joined in series. The coils may now be wired up and fixed condensers and resistors wired in as required.

The remainder of the wiring can now be completed. The battery cable is connected up last of all. As each wire is soldered in place, jot down the colour and designation, so that there will be no mistakes when the cable is connected up to the batteries. Finally, make a thorough check of all connections from both the theoretical and layout diagrams.

Then insert the 60 m.a. fuse bulb in the fuse-holder. Reverse the chassis and fit the control knobs in place. When the batteries are connected up, the valves plugged in, the aerial and earth leads attached, and the speaker plug inserted, the set is ready for test.

The condenser gang should be lined up on a station near the middle of the dial, with the reaction control set so that the receiver is in its most sensitive condition, i.e., just before oscillation commences. Adjust the trimmer of the detector section of the gang for loudest results, and then the second and first r.f. sections in turn, peaking each until volume is loudest.



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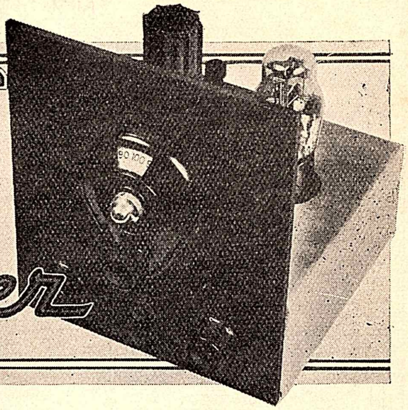
The "Tiny Tim" All-waver



ALMOST any "old-hand" constructor will tell you that one of the greatest thrills he ever experienced in radio was in his beginner days—when he soldered in place the last wire of his first one-valver, connected it up, switched on, and heard music in the phones. And every one who builds up this compact little all-waver will think likewise.

Coil Details

Band	L1 (Primary)	L2 (Secondary)	L3 (Reaction)
Broadcast	25	100	30
80-metre	6	18	10
40-metre	4	12	8
20-metre	2	5	5

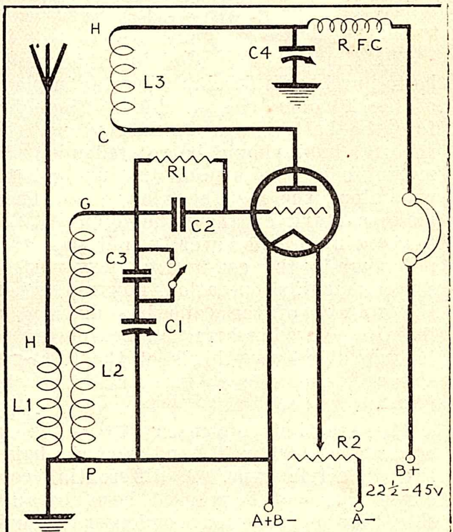
Though it is extremely simple to construct—the diagrams have been prepared in such detail that anyone with not the slightest knowledge of radio could build it successfully—yet it is capable of putting up a splendid performance. Of course, as there is only one valve, the number of stations that can be picked up will depend largely on the efficiency of the aerial and earth installation. A constructor in Thames, who built up a similar set described last year in the "N.Z. Radio Times," holds verifications from no less than ten of the main Australian stations. Certainly, his location is an excellent one for DX reception, and he has a good aerial and earth, but this just shows what results *can* be obtained on the broadcast band with a set of this type.

All the thrills of shortwave listening can be enjoyed with the "Tiny Tim," too, because it has been designed to cover the shortwave bands as well. When one has mastered the art of tuning on these bands, it is possible to pick up stations all over the world. The Empire station at Daventry, FYA, Paris, and 12RO, Rome, are only three of a number of these stations tuned in on the phones during tests.

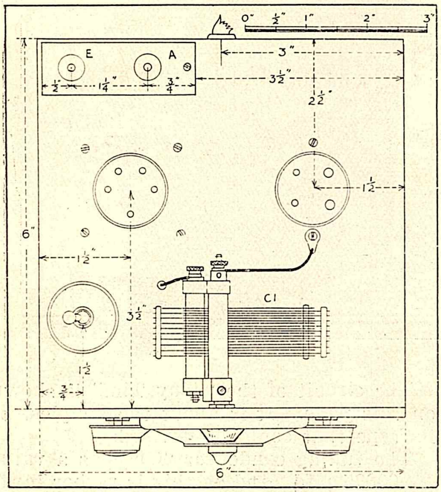
The circuit of the "Tiny Tim" is shown on this page. It is about the simplest of its type that could be devised.

The tuning condenser "C1" has a value of .00035 mfd., and as this is rather large for easy tuning on shortwave, provision has been made to switch in a series fixed condenser "C3" when the set is being used for shortwave listening. This condenser has a value of .0002 mfd., and when the switch in parallel with it is open, the effective tuning capacity is reduced to .00013 mfd.—a suitable value for shortwave work.

The grid leak "R1" and grid condenser "C2" have values of 4-6 megohms and .0002-.0003 mfd. respectively.



The circuit of the "Tiny Tim." C1 = .00035 mfd. variable condenser; C2 = .0002 — .0003 mfd. grid condenser; C3 = .0002 mfd.; C4 = .0003 mfd. reaction condenser. R1 = 4-6 megohm grid leak; R2 = 10 ohm rheostat.



The above-chassis diagram.

No on/off switch has been incorporated, because when the rheostat "R2" is turned completely off, the filament circuit is broken. The set has been designed for operation with a 2-volt accumulator, though two 1½-volt cells connected in series will give many months of service. If the latter are used in conjunction with a 2-volt valve, it will be necessary to include a resistance of approximately 17 ohms in series to break the voltage down to the required 2 volts.

The simplest way of doing this would be to purchase a 30 ohm rheostat in place of the 10 ohm one specified. Then, before the batteries are connected up, the rheostat knob should be rotated until the moving arm is at a point just under halfway along the resistance element. Then make a mark on the panel opposite the knob pointer, and never turn it past this point while the cells are new. After several months' operation, however, when the voltage of the cells has dropped a little, the moving arm can be rotated to include about two-thirds of the total resistance, and a fresh mark made on the panel.

The reaction condenser "C4" has a capacity of .0003 mfd., and is of the bakelite dielectric type. A differential condenser has not been used here, because this type of reaction condenser, though quite satisfactory for broadcast band reception, is unsuitable for shortwave work.

The r.f. choke should be of high quality and it would be an advantage if it were of the special shortwave type. One of these could quite easily be wound at home, as explained in Section 4.

A phone jack, which is mounted on the front panel, has been incorporated as the most convenient and up-to-date method of connecting the head-phones in circuit, though if desired, phone terminals can be used instead.

Building The "Tiny Tim."

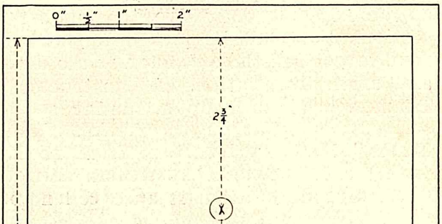
The first step towards building the receiver is to assemble all the parts specified in the panel on page 32. Though the aluminium chassis could be prepared at home, it is best to purchase it already stamped and drilled, according to the specifications given in the above-chassis sketch.

Construction is commenced by drilling the panel, and the best way to do this is to place it face downwards on several thicknesses of tissue paper to protect the highly-polished surface. Then mark out on the back the centres of the four holes required to take the shafts of the panel components, i.e., the tuning condenser, reaction condenser, rheostat, and phone jack. Then carefully drill these holes, and when the job is complete, the panel may be placed on one side and the task of winding the coils commenced.

Details Of The Coils.

Four coils are required, one to cover the broadcast band and three for shortwave. If the sketch shown on page 30 and the instructions given below are closely followed, they will be found quite simple to wind.

Marquis coil formers have been used, and they simplify the winding considerably. All the coils are wound in the same way, and so it will be sufficient to outline the procedure for winding the broadcast coil.



Dimensions for drilling the front panel.

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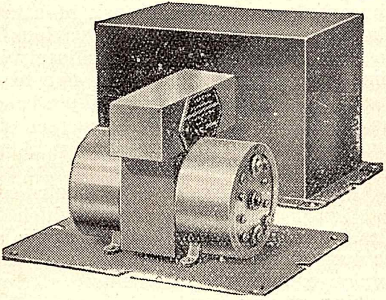

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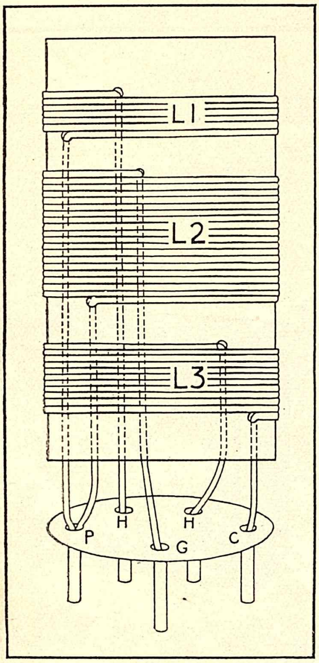

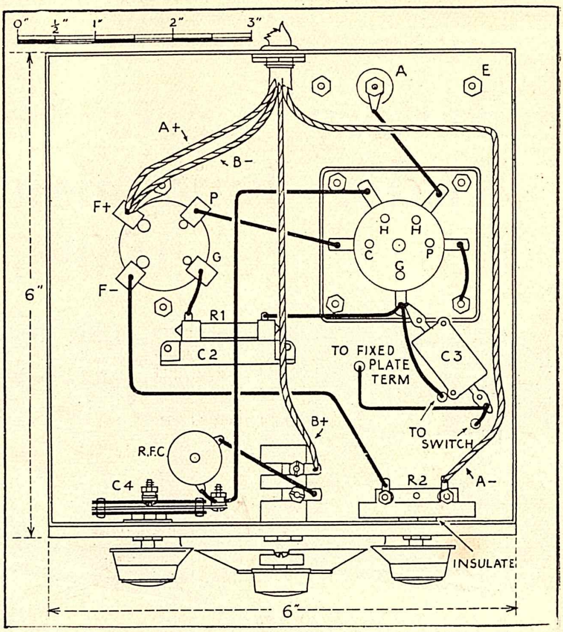

Left: This sketch shows the method of winding the coils. Above: The under-chassis wiring diagram.

First of all, undo the screw holding the base of the former in place and remove the base. Next, at the bottom of the ribbed portion of the former, drill through two very small holes parallel to the top of the former.

Now pass the end of the 34 d.s.c. wire through one hole from the outside. Turn it back inside the former and pass it through the other hole. Finally, pass it back once more through the first hole, pull it fairly tight, and leave the end projecting downwards from the inside of the former. About four inches should be left for connection purposes.

Now close-wind on 30 turns, and when the last turn is completed make two more holes immediately above the winding, break the wire, and secure it as before. This completes L3, the reaction winding.

L2 and L1 are put on in an exactly similar way, L2 having 100 turns and L1, 25. As it is a rather laborious task to count many turns of such fine wire, the windings can be put on by measurement. There are 85 turns of 34 d.s.c. to the inch, and so the winding length for the broadcast secondary (L2) should be just under 1.2 inches. The distance left between the windings should be ⅛in.—not more, or it will be found that the three windings cannot be accommodated on the former, which is 2½in. long. For this reason care should be taken to commence winding L3 at the extreme lower end of the former.

The windings are now complete, and there only remains the task of attaching the base and soldering the various leads to their correct pins. Immediately below the former, bare each of the five leads of its covering. Now take the 5-pin base and pass each lead through its correct pin, as shown in the diagram. The grid pin is the one furthest away from all the others.

When the wires are in their correct positions, put in the screw which holds the base in position. Then apply a hot soldering iron to the tip of each pin and solder each wire into place, afterwards cutting off any surplus close up to the pin. Lastly, smooth the pins up with a file, taking off any surplus solder so that the former will plug in the coil socket smoothly and without sticking.

The shortwave coils are wound in an identical manner, except that 22 d.s.c. is used for the primaries and secondaries (L1 and L2), and 30 d.s.c. for the reaction winding (L3). Also, as the number of turns required on each is relatively few, the windings on the shortwave coils can be spaced from 1-8in. to ¼in., while the 20 and 40-metre band secondaries can with advantage be space-wound. This means that a space of perhaps 1/16in. to 1-8in. is left between each turn.

If reaction is found to be too fierce on the shortwave bands, L3 can be moved down the former away from L2 with the finger-nail, until the amount of feed-back can be controlled. Conversely, in the remote possibility of the set not oscillat-

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List of Parts.

1 chassis, punched and drilled as shown.
1 ebonite panel, drilled as shown.
1 .00035-mfd. variable condenser.
1 vernier dial.
1 .0003 mfd. bakelite dielectric reaction condenser.
1 10 or 15-ohm rheostat.
2 small knobs (Marquis).
1 small tumbler or toggle switch.
1 4-pin wafer socket (Renrade).
1 5-pin coil socket (Marquis).
4 5-pin coil formers (Marquis).
1 .0002-mfd. mica condenser (T.C.C., Standard, or Solar).
1 .0002-.0003 mfd. mica grid condenser (T.C.C., Standard, or Solar).
1 4-6 megohm grid-leak (Ohiohm).
1 shortwave r.f. choke.
1 phone jack.
1 phone plug (Marquis).
1 4-wire battery cable.
1 pair headphones (S.T.C.)
1 type 30 valve (Radiotron, Raytheon, Sylvania, Nat. Union, Tungsol) or 1—A415 (Philips) or 1—PM2DX (Mullard).

BATTERIES.

1 45v. "B" battery (Columbia, Full-O-Power, Burgess, Hellesen's).
1 2v. accumulator (20, 40 or 60-amp. hours). (Exide.)

MISCELLANEOUS.

2 terminals, "A" and "E," mounted on an ebonite strip, 1 large bush, 1 small bush, 1 coil Henley push-back wire, 1 doz. assorted nuts and bolts, ½ doz. solder tags, small quantities of 22 d.s.c., 30 d.s.c. and 34 d.s.c. for winding coils.

ing with one of the coils, then L3 can be moved closer to L2 until it does.

Assembling The Components.

When the coils are complete they may be laid aside while the panel and chassis components are mounted. The latter comprise the sockets for the coil and valve, the bush for the battery cable, the aerial and earth terminals, and the small tumbler or toggle switch. When mounting these, make sure that the aerial terminal is insulated from the metal chassis, either by means of an insulating bush or by using a small ebonite terminal strip, as shown in the diagram.

Next, the tuning condenser and dial can be mounted. Finally, the ebonite panel should be placed in front of the chassis and the reaction condenser, phone jack and rheostat locked in position, thus holding the panel to the chassis. Be careful to ensure that the phone jack and the shaft of the rheostat are insulated from the aluminium chassis.

Hints About The Wiring.

The set is now ready for wiring up. There is no need to give the wiring in words, as it is made abundantly clear in the various diagrams. All earth leads should be soldered to tags placed under the nuts of convenient bolts.

When the wiring is completed, check it over very carefully from both the theoretical and the layout diagrams to ensure that no mistakes have been made. Then, when you are satisfied that everything is correct, the set is ready for its first try-out.

There are only four wires in the battery cable: that marked "A —" on the under-chassis diagram should be connected to the negative or black terminal of the accumulator; "A+" to the red or plus terminal of the accumulator; "B —" to negative of the "B" battery; and "B+" to a tap between 22½ and 45 volts. It will probably be found that the set will slide into oscillation smoothest when the 22½ volt tap is used.

When the batteries are connected up, the valve and broadcast coil can be plugged in, the aerial and earth connected up, and the phone plug inserted in the jack.

If the 2 volt accumulator is used, the rheostat should be rotated until it is full on. Now rotate the reaction condenser knob, and at one point of its travel a soft "plop" should be heard in the phones. This indicates that the set is oscillating, and the control should be slackened back to a position just before that where the "plop" occurred. A lively hissing sound should now be heard in the phones, indicating that the set is in its most sensitive condition. The tuning dial control should then be slowly rotated and a station should soon be picked up.

When tuning the receiver, operate the reaction and tuning condenser controls so as to keep the lively hissing noise always present in the phones. As mentioned before, this indicates that the set is in its most sensitive condition. Never permit the set to break into oscillation, as by so doing you are not only interfering with the reception of others for miles around, but the set is then not nearly so sensitive for DX reception.

◆

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HOW often do we hear the cry, "Buy British," and how seldom do we think just what it means—when, after all, it is but an appeal to our common-sense. For New Zealand's future prosperity is dependent on reciprocal trade with Britain —and so it is only common sense to buy British. Empire goods lead the field, and particularly is this true of the fine new lines of His Master's Voice radio sets.

To see the beautifully designed cabinets and to hear the wonderful tone of these sets proves this statement to the full. They represent such splendid value that in radio, at least, there is no excuse for not buying British.—P.B.A.

The "Super Quality Six"

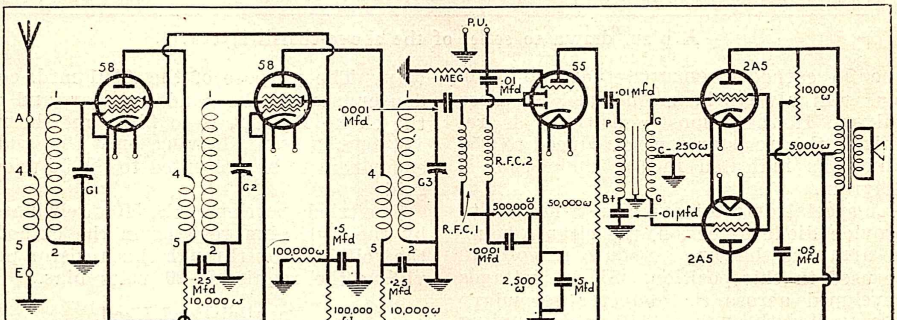
WHILE designed primarily for high-quality reproduction, this six valve t.r.f. receiver is capable of bringing in Australian, Japanese and several American stations at good speaker volume. It is quite selective enough for all locations, except perhaps within a mile or so of a powerful local, and even then a wave-trap will sharpen up tuning sufficiently to permit of reception of distant stations while the local is operating.

To those who are accustomed to reproduction from a single pentode, the beautifully balanced tone given by diode detection and 2A5's in push-pull will be a revelation.

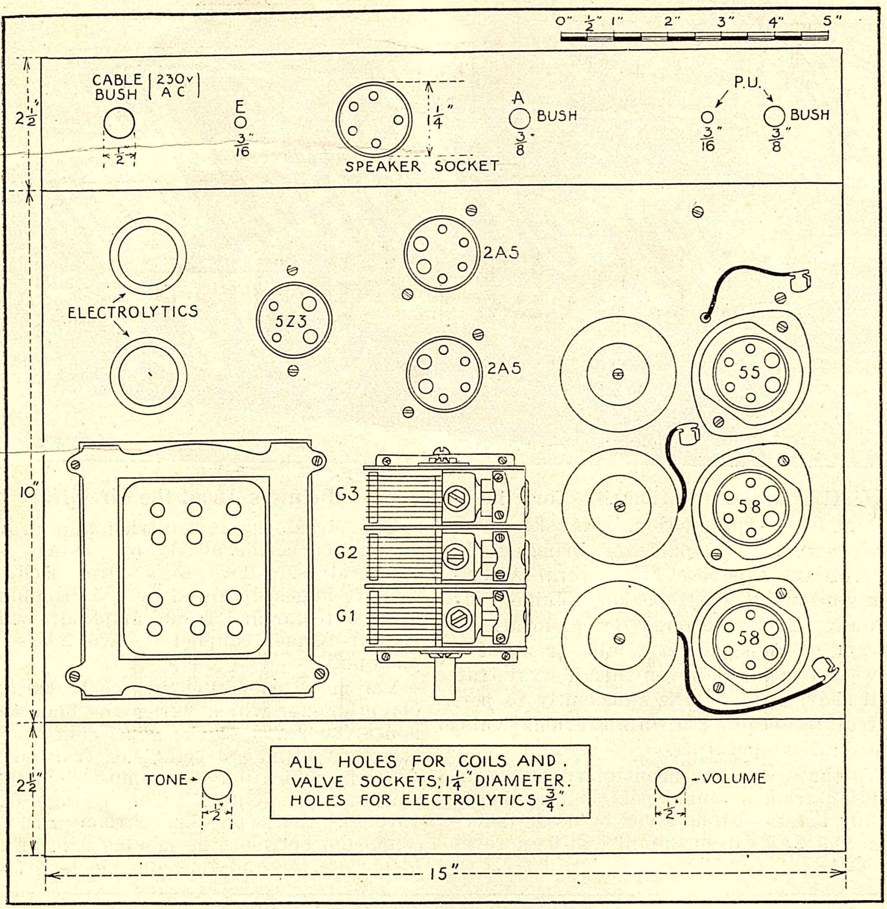
Pointers About the Circuit.

The circuit is a well-tried and proven favourite, modernised by using six-pin valves. Two 58's are used in the r.f. stages, followed by a 55 combined diode detector and triode amplifier, which is transformer coupled to two 2A5's in push-pull.

Volume is controlled by the 10,000 ohm potentiometer which varies the bias (and hence the gain) of the super-control 58's between -3 and -40 volts, i.e., from maximum amplification to almost complete plate current cut-off. The voltage drop through the 300 ohm carbon resistor, connected between the moving arm of the potentiometer and the common lead from



The circuit of the "Super-Quality Six."



A plan, drawn to scale, of the above-chassis layout.

the 58 cathodes, ensures that minimum bias will always be maintained on these valves. If the utmost sensitivity is required, this resistor can be reduced to 250 ohms, as indicated in the under-chassis diagram.

A special detector coil is not needed to provide diode detection, the circuit being so arranged that any standard r.f coil can be used in this position. Signal voltages developed across the detector secondary are applied through a .0001 mfd. coupling condenser to the diode plates of the 55, which are tied together to provide half-wave diode detection. One of these plates can be used if desired for automatic volume control, as will be explained later. The r.f. choke R.F.C.1 should be a high-quality component to ensure that no leakage of signal voltages will take place.

The audio component of the signal, developed across the 500,000 ohm diode load resistor, is applied through an r.f. choke and a .01 mfd. coupling condenser to the grid of the 55 triode section, where it is amplified and passed on in the normal way. The purpose of the .0001 mfd. condenser across the load resistor and of the choke R.F.C.2, is to filter out the r.f. voltages present, leaving only the audio component to be presented to the 55 triode grid.

The triode portion of the 55 is self-biased by the 2500 ohm resistor in the cathode, the voltage drop through this resistor providing the requisite -20 volts bias.

Parallel Feed Used.

The 55 plate is parallel-fed to avoid passing the plate current of this valve through the primary of the input push-pull transformer, and to reduce hum to a minimum.

The push-pull 2A5's are self-biased by means of the 250 ohm, 100 mil., wire-wound resistor in the common cathode lead. The voltage developed across this resistor should, if possible, be measured and the resistance adjusted until the bias is exactly 16.5 volts. As 250 ohm wire-wound resistors are not readily obtainable, two 500 ohm resistors connected

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in parallel can be used to provide the correct resistance.

A 10,000 ohm potentiometer and a .05 mfd. fixed condenser, connected in series from plate to plate of the 2A5's, provide an effective tone control.

Either an 80 or a 5Z3 is suitable for a rectifier. If the former is used, then the 5000 ohm voltage-dropping resistor shown connected between the primary centre-tap of the push-pull output transformer and the 2A5 auxiliary grids can be omitted. With the 5Z3, however, the voltage on the auxiliary grids without this resistor would be rather too high for safe working.

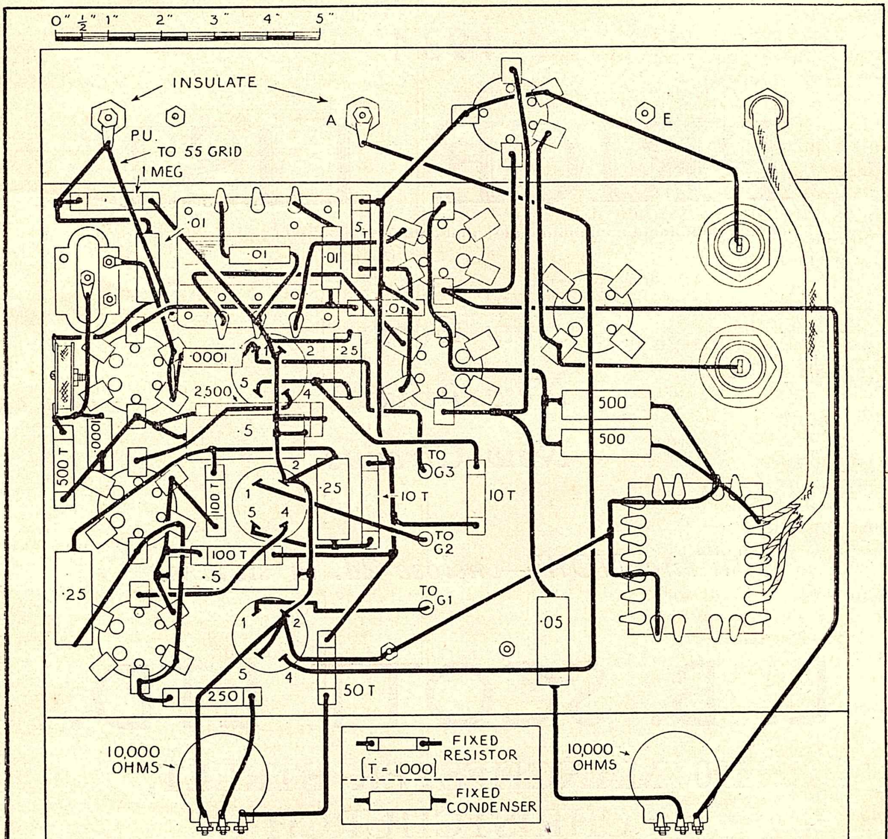
The speaker required is one with a 1200 ohm field, and with an input transformer to match push-pull 2A5's. Generous baffling should be provided to bring out the fine quality obtainable from the set.

Building the "Super-Quality Six."

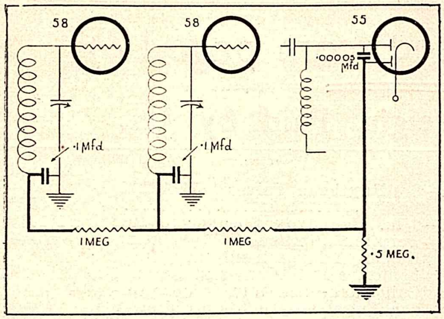
All the parts required for building this receiver are given in the accompanying panel. After they have been assembled, the first task is to mount the valve sockets and shield bases on the chassis.

Take care to mount the sockets so that the heater pins are facing as shown in the diagrams, as these have been so arranged that the resultant leads will be as short as possible. The 58 and 55 heater pins should be nearest the outside of the chassis, those of the 5Z3 should be in the same direction, and those of the 2A5 in the opposite direction. The heater pins of the speaker socket should face in the same direction as those of the 2A5's. The three coils can now be mounted in the positions shown.

A 4in. length of push-back wire should be soldered on to each of the lower solder tags of the gang, which should then be bolted into position. Then mount the tone control potentiometer, taking care to insulate it from the chassis. The power transformer comes next, followed by the audio transformer and the electro-



The under-chassis layout, showing the wiring. The 55 plate feed resistor has a value of 50,000 ohms.



A.V.C. can quite simply be fitted to the "Super-Quality," as shown by this sketch. The heavily-drawn lines indicate the additions.

lytics, which incidentally do not require to be insulated from the chassis.

Now wire up the heaters, and earth the centre tap of the two 2.5 volt windings used. The heater wiring is not shown in the under-chassis diagram for the sake of clarity.

The two 58's and the 55 heaters are run from one winding and the 2A5's from the other. To wire them up, solder two lengths of push-back wire to the solder tags of one 2.5 volt winding. Twist these leads together and solder them to the heater pins of the first 58 socket, first cutting off any surplus. Another two leads are also soldered to this socket, twisted together, and taken to the heaters of the next 58, and from there still another pair is taken to the heaters of the 55 valve. The 2A5 heaters are wired in exactly the same way, from the other 2.5 volt winding.

Now mount R.F.C.1, which, as mentioned before, should be a good quality choke of fairly high inductance. The condenser gang, coils, valve sockets, audio and power transformers may now be wired up, the other components being connected in place as required. The under-socket connections for all the valves are shown on the circuit diagram.

Before wiring the aerial coil and the first 58 valve, fit the volume control potentiometer, insulating its shaft from the chassis. Then attach a length of flex to the free terminal of R.F.C.2, pass it through a hole in the chassis, and fit it with a grid clip. This is the 55 grid lead.

Before wiring in the lead from the aerial terminal to terminal 4 of the aerial coil, slip over it a length of copper braid to which a short length of bare 18 or 20 gauge tinned copper wire has been soldered. This wire should be run to the nearest convenient earthing point. Be very careful to ensure that the braid does not touch the wire within where it emerges from its insulation. Otherwise the set will be unaccountably silent when it is first switched on. Also be careful to see that the braid does not short any resistor or condenser to earth.

Direct Wiring the Best.

It will be noticed in the under-chassis diagram that some leads, notably that to the aerial coil, are not taken direct to their destinations. This is purely for the sake of clarity. In actual practice leads should be well spaced, short, and as direct as possible. Do not attempt to make neat right-angle bends, as this increases the length of the wiring and also the possibility of instability.

List of Parts.

1—chassis, drilled and stamped as shown in sketch.
1—3 gang variable condenser, .00035 mfd. per section, (Radiokes).
1—dial, with 2.5v. dial light and knob (Radiokes).
3—coils, with shield cans (1 aerial and 2 r.f.) (Radiokes, Lekmek).
3—type 58 valve shields.
1—type 1-32 power transformer (Radiokes).
1—type 3-9 audio transformer (Radiokes).
1—4-pin, 1—5-pin, 5—6-pin wafer sockets (Renrade).
2—r.f chokes (Radiokes and Lotus).
2—10,000 ohm vernier potentiometers, with insulating washers (Marquis).
2—knobs (Marquis).

FIXED CONDENSERS.

2—.5 mfd. (T.C.C., Standard or Solar).
3—.25 mfd. (T.C.C., Standard, or Solar).
1—.05 mfd. (T.C.C., Standard or Solar).
3—.01 mfd. (T.C.C., Standard or Solar).
2—.0001 mfd. (T.C.C., Standard or Solar).
2—8 mfd. wet electrolytics, 500v. test (T.C.C., Standard, Sprague).

FIXED RESISTORS.

1—1megohm 1 watt carbon (Ohiohm).
1—.5 megohm 1 watt carbon (Ohiohm).
1—.1 megohm 1 watt carbon (Ohiohm).
2—50,000 ohm 1 watt carbon (Ohiohm).
2—10,000 ohm 1 watt carbon (Ohiohm).
1—5,000 ohm 1 watt carbon (if required) (Ohiohm).
1—300 ohm 1 watt carbon (Ohiohm).
1—250-300 ohm, 100 m.a. wirewound (16.5v to be developed, for push-pull 2A5 bias).

VALVES.

2—58, 1—55, 2—2A5, 1—80 or 5Z3 (Raytheon, Radiotron, Sylvania, National Union, Tungsol).

SPEAKER.

1—dynamic speaker with 1200 ohm field, with transformer to suit push-pull 2A5's (Jensen, Magnavox).

MISCELLANEOUS.

1 large bush; 2 small bushes, 4 terminals ("A," "E," and two "P.U."); 3 s.g. clips; six-foot length power flex and adaptor; 1 coil Henley push-back; 6in. push-back flex (55 grid lead); 1 foot flexible metal braiding (to shield aerial lead to coil); 2 doz. assorted nuts and bolts; solder tags.

(KITSETS—Continued from page 17)

All Prices Include Freight Paid by Us.

Public Address: 12 Watt Amplifier (Continued.)

	£	s.	d.
1—Pair Special Radiokes Coils ...		13	6
7—Wafer Sockets 3/4 pin, 2/5 pin, 2/6 pin		3	6
2—Valve Shields		4	6
1—10,000 ohm Marquis Potentiometer		5	9
1—Radiokes R.E. Choke		2	0
2—.0001 S.T.C. Condensers		2	0
1—.1 T.C.C. Tubular Condensers ..		1	0
4—.25 T.C.C. Tubular Condensers ..		5	0
1—4 mfd. T.C.C. Dry Electrolytic		5	0
2—10 mfd. Dulytic Condensers ..		7	0
2—8 mfd. Sprague 500-volt Electrolytic Condensers		9	0
1—Set Raytheon Valves 1/58, 1/57, 1/56, 2/2A3, 1/5Z3	5	5	0
1—Jensen D8 Concert Model Speaker	7	10	0
2—Bushes large and small, power flex and plug, 2 grid Clips, Bulgin Output Plug and Socket, Mounting Strip, 2 Terminals, 2 doz. Asstd. Nuts and Bolts, 1 Coil Henley Push-back Wire ...		15	0
5—1 Watt Resistors 1/400; 1/2000; 1/10,000; 2/¼ meg		5	0
1—750 Ohm Radiokes Maxome Resistor		1	6
1—Voltage Divider		3	9
1—Set Raytheon Valves 1/56, 1/2A5, 1/80	1	5	3
1—6½in. Magnavox Speaker to suit	1	10	0
3—Terminals, 2 small insulating Bushes, 1 large insulating Bush, 1½ doz. asstd. Nuts and Bolts, 1 Coil Push-back Wire, 1 doz. Solder Lugs, length 3 Core Power Flex, with plug		7	6

KIT OF PARTS **£19/15/0**

KIT OF PARTS **£7/2/6**

1934 CRYSTAL AMPLIFIER.

	£	s.	d.
1—Chassis Stamped and Drilled ..		7	6
3—Wafer Sockets 1/4 pin, 1/5 pin, 1/6 pin		1	6
1—Power Transformer, Radiokes M2		18	6
1—Ferranti AF10 Transformer		13	6
1—Radiokes 3-6 Transformer		14	0
1—.1 T.C.C. Tubular Condenser ...		1	0
1—.25 T.C.C. Tubular Condenser .		1	3
1—10 mfd Dulytic Condenser		3	6
1—25 mfd Dulytic Condenser		4	6
2—8 mfd Sprague Electrolytic Condensers		9	0
2—10,000 Ohm Marquis Potentiometers with Knobs		11	6
2—1 Watt Carbon Resistors 1/10,000, 1/2000		2	0
1—450 Ohm Radiokes Maxome W/W Resistor		1	6

THE SUPER "QUALITY SIX."

	£	s.	d.
1—Chassis Drilled and Stamped ..		7	6
1—3-Gang Stromberg Carlson Condenser	1	5	0
1—Radiokes Pan Dial		5	9
1—Dial Light and Knob		2	6
1—Set Radiokes Coils	1	0	0
3—Valve Shields		6	9
1—M5 Radiokes Power Transformer	1	5	0
1—3-9 Radiokes Push Pull Transformer		14	0
7—Wafer Sockets 1/5 pin, 1/4 pin, 5/6 pin		3	6
2—3-20 Radiokes R.F. Chokes		4	0
2—10,000 Ohm Marquis Vernier Potentiometers with Knobs		11	6
2—.5 T.C.C. Tubular Condensers .		3	4
3—.25 T.C.C. Tubular Condensers .		.3	9
1—.05 T.C.C. Tubular Condenser ..			10
3—.01 T.C.C. Tubular Condensers .		2	6
2—.0001 S.T.C. Midget Condensers .		2	0
2—8 mfd Sprague Electrolytic Condensers		9	0
9—1 Watt Carbon Resistors, 1/1 meg; 1/.5 meg; 1/.1 meg; 1/50,000; 3/10,000; 1/5000; 1/300 .		8	0
1—200 Ohm 100 mil Maxome Radiokes Resistor		1	6
1—Jensen D19 10in. Cone Speaker 1200 Ohm field, etc.	3	5	0
1—Set Raytheon Valves 2/58, 1/55, 2/2A5, 1/80	2	18	3
1—Large Bush, 2 small Bushes, 4 Terminals, 3 S.G. Clips, 6ft. Power Flex and Adaptor, 1 Coil Henley Push-back Wire, 6in. Push-back Flex, 1ft. Flexible Metal Braiding, 2 doz. asstd. Nuts and Bolts		10	0

KIT OF PARTS **£13/5/0**

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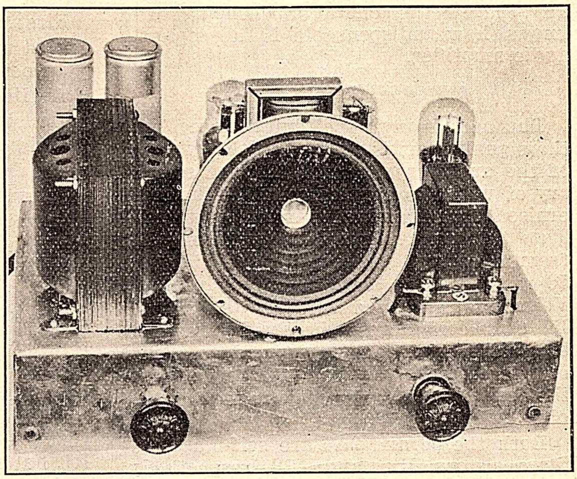
Lining Up.

When all the wiring has been completed, it should be very carefully checked over from the theoretical and layout diagrams, the various leads being ticked off as they are found to be correct. Then when the power flex has been fitted, the set is ready for test. Insert all the valves, except the rectifier, and switch on. All the heaters should show a dull red glow. If so, connect up the aerial and earth, plug in the speaker, and insert the rectifier.

The operation of lining up the set is very simple. Choose a station near the middle of the broadcast band, i.e., with the moving vanes about half-way out of mesh, and turn the volume well down. Adjust the trimmer on the detector section of the gang first of all, setting it for peak results. Then work on the r.f. and

(*Continued on page 44*)

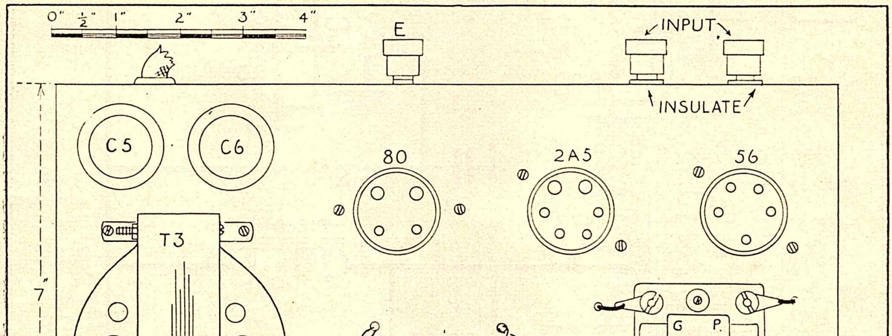


The experimenter will find many uses for this self-contained amplifier, which employs a 56 as driver for a 2A5 output pentode. It has its own built-in power supply, and uses one of the latest midget dynamics.

The "1934 CRYSTAL AMPLIFIER"

THERE are three classes of experimenters to whom this self-contained audio amplifier will appeal. First of all, the beginner who has built a crystal set can not only obtain a full loudspeaker volume from his locals with it, but also he can learn a great deal about a.c. construction by building it. It is for this class of constructor that the diagrams have been prepared in such detail. In addition, if desired, the amplifier can be pulled down after it has been in operation for several months and most of the parts used to build a larger set.

Next, the short-wave enthusiast who usually builds his set for headphone reception will find this amplifier very handy for stepping up signals to speaker volume



This sketch shows the disposition of the above-chassis components.

for the entertainment of his family. Finally, there is the general experimenter who knows how indispensable is a separate audio amplifier.

A Conventional Circuit.

The accompanying circuit shows that the signal input is applied to the primary of the audio transformer, T1, the secondary of which is coupled to a 56—the modernised and improved version of the 27. This transformer provides sufficient lift from a crystal set signal to enable the 56 to load fully the 2A5 output pentode. Volume is controlled by the potentiometer R1 connected across the secondary. The 56 is also transformer coupled to a 2A5 output pentode, which in turn feeds one of the new baby midget speakers with a 2500 ohm field.

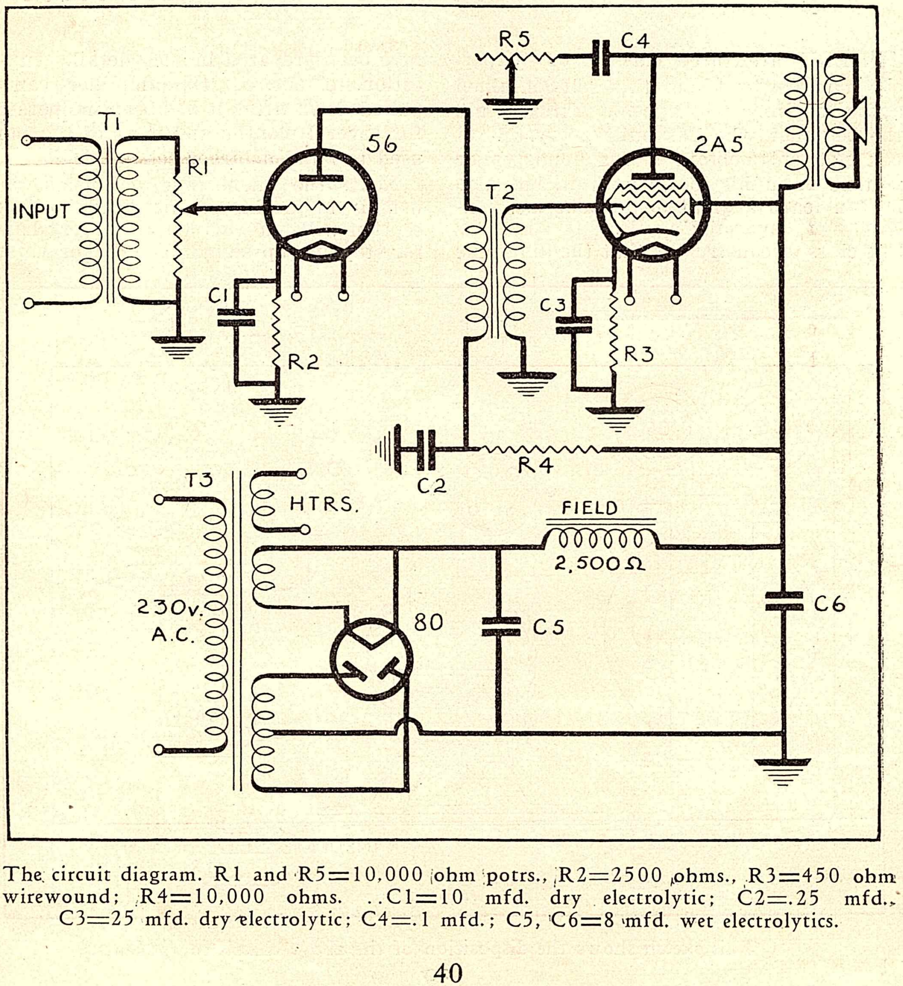
Both the 56 and 2A5 are self-biased by the resistors, R2 and R3 respectively, placed in the cathode leads. Tone is controlled in the ordinary way by C4 and R5.

Building the Amplifier.

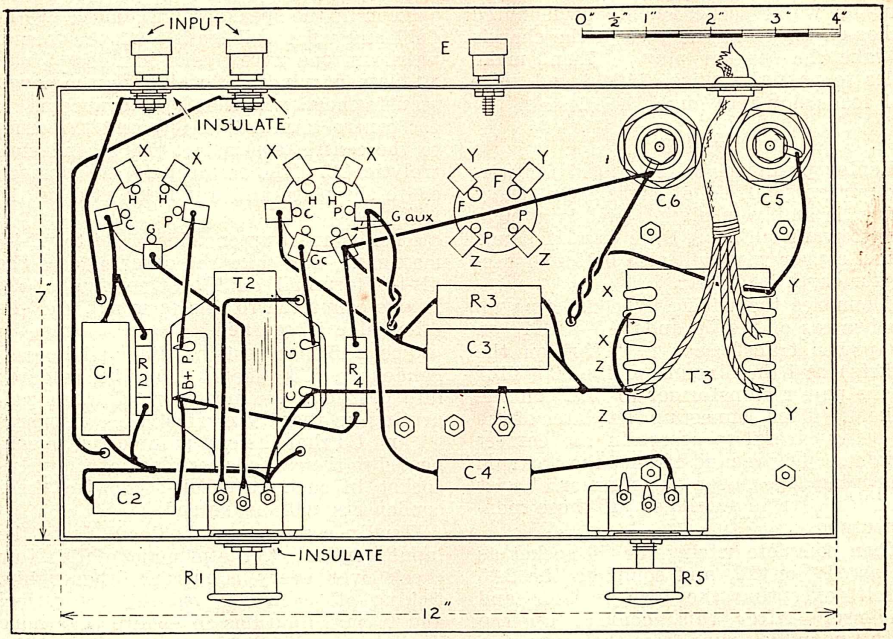
First of all, a chassis stamped and drilled as shown in the diagram should be procured, together with the requisite parts listed in the panel. A further diagram shows the mounting of the above-chassis components.

The wafer valve sockets are mounted first, with the heater holes to the rear; then mount the three bushes in the rear wall (a triangular file is useful to hold them with when screwing them into position). When the three terminals are bolted into position, the mounting holes for the power transformer should be drilled. The electrolytics are mounted next, followed by the power transformer, and then the potentiometers, R1 and R5. Insulate the shaft of the volume control R1, but not that of the tone control, R5.

Next come the audio transformers T1 and T2, the front bolt passing through



The circuit diagram. R1 and R5=10,000 ohm potrs., R2=2500 ohms., R3=450 ohm wirewound; R4=10,000 ohms. C1=10 mfd. dry electrolytic; C2=.25 mfd. C3=25 mfd. dry electrolytic; C4=.1 mfd.; C5, C6=8 mfd. wet electrolytics.



How to wire up the under-chassis components.

the chassis serving as one support for both. Drill four holes for the leads to T1.

If a midget speaker is to be used, as in the original, then the speaker mounting only should be bolted in place. If a larger speaker is to be used, then the usual

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four-pin wafer socket should be mounted either on top or at the back of the chassis to take the speaker plug. Then make holes to pass the pairs of field and voice coil leads down through the chassis.

Wiring.

Henley push-back wire is ideal for wiring purposes. It is of sufficiently heavy gauge, is amply insulated, and is a pleasure to work with. A little bare 18 gauge tinned copper wire will also be found useful for earth leads, etc.

Commence the wiring by connecting up the heaters of the 56 and 2A5 ("XX" on the power transformer to "XX" on the sockets) and the filament of the 80 ("ZZ" on the power transformer to "ZZ" on the socket). Then connect up the plates of the 80, being careful to ascertain the correct terminals beforehand from the carton containing the power transformer. Twist all leads carrying a.c., i.e., all those mentioned above.

Then complete wiring the 56 socket as far as "P" on T2, and complete the 2A5 circuit, excepting the bias resistor and condenser. After this, connect up the earth line, which runs from the centre tap of the 2.5 volt filament winding to the earth terminal of the power transformer panel, to "C—" of T2, and then to the earth end of R1. This line is effectively earthed by soldering it to a solder tag attached under the nut of one of the bolts holding the speaker mounting in place.

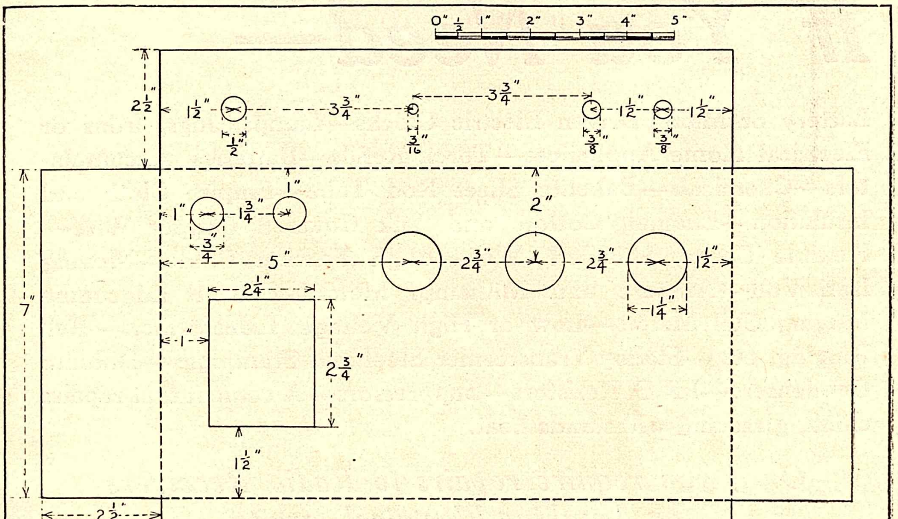
Then fit the speaker and connect up the field and voice coil leads. Of the former pair, run one wire to the handiest 5 volt 80 filament winding terminal on the power transformer (which is also connected to the centre terminal of C5) and the other to the centre terminal of the second electrolytic C6. The latter pair are connected to the plate and auxiliary grid of the 2A5.

Then connect up one side of R4 to "B+" maximum, and take the other side to the "B+" terminal on T2. One side of C2 is also connected to this terminal, and the other side is earthed.

The 2A5 bias resistor, R3, and by-pass condenser, C3, should now be soldered into position. Be most careful when connecting up the dry electrolytic condensers C1 and C3 that the end painted red is connected to the cathode terminal of the valve socket in each case, or otherwise these condensers will be ruined.

Finally connect up the leads from the input terminals to the primary of T1. Now check over every connection thoroughly, ticking off each one on the theoretical and layout diagrams to ensure that none have been missed. Now connect up the three-core power flex, taking the red wire to "240"; the black to "C"; and the remaining wire to earth.

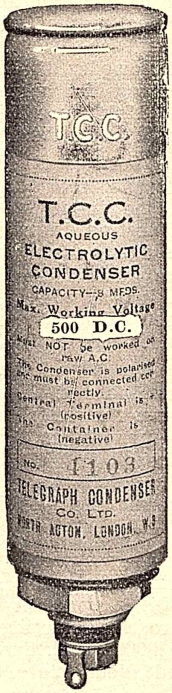
Fit the two knobs to R1 and R5, plug in the valves and switch on. Watch the rectifier for a blue glow, which denotes an overload caused by a short circuit



Dimensions for drilling and stamping the chassis.

T.C.C.

ELECTROLYTIC CONDENSERS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T.C.C.
AQUEOUS
ELECTROLYTIC
CONDENSER
CAPACITY—8 MFDS.
Max. Working Voltage
500 D.C.
Must NOT be worked on raw A.C.
The Condenser is polarised and must be connected correctly.
Central Terminal is + (positive)
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somewhere. In this case switch off immediately and check over the wiring for faults. If the filament of the 80 shows a cherry red, the heaters of the other two valves light up, and a faint hum can be heard when the ear is placed close to the speaker, then the amplifier is almost certain to be functioning correctly.

Do not worry if the electrolytics crackle a little for ten or fifteen minutes, as they are merely forming up. This will not occur again, except after a long period of disuse.

General Hints.

The general order of construction outlined above is the logical method of building the amplifier, and the instructions should be closely followed. Solder all joints and use solder tags for all terminals and earth points. Make sure the leads to T2 do not touch the metal frame.

To connect the amplifier to a crystal set, merely connect two leads from the headphone terminals to the input terminals of the amplifier. If desired, the amplifier can be built into a midget cabinet and the crystal set rebuilt to fit into the space above T1, thus making a self-contained and compact little set. However, this is left to the ingenuity of the constructor.

To connect a pick-up, attach the two tags to the input terminals of the amplifier. If, when using the amplifier for pick-up work, any hum is experienced, due to the proximity of the 56 to the gramophone motor, a shield-can fitted to this valve will overcome the trouble.

List of Parts.

1—Chassis, drilled and stamped as shown.
3—Wafer sockets, 1—4 pin, 1—5 pin, 1—6 pin (Renrade).
1—Power transformer (Radiokes 1-2).
1—Audio transformer (Ferranti A.F.10)
1—Audio transformer (Radiokes 3-6)

FIXED CONDENSERS.

1—.1 mfd. (T.C.C., Standard or Solar)
1—.25 mfd. (T.C.C., Standard or Solar)
1—10 mfd. dry electrolytic, 25v. working (T.C.C.).
1—25 mfd. dry electrolytic, 25v. working (T.C.C.).
2—8 mfd. wet electrolytics (T.C.C., Sprague).

RESISTORS.

2—10,000 ohm. potrs., and insulating bush, with knobs (Marquis vernier).
1—10,000 ohm. carbon (Ohiohm).
1—2500 ohm. carbon (Ohiohm).
1—450 ohm. 75 m.a. wirewound resistor (Radiokes).

VALVES.

1—56; 1—2A5; 1—80 (Raytheon, Radiotron, Nat. Union, Sylvania, Tungsol).

SPEAKER.

1—Midget dynamic speaker, to match 2A5 2500 ohm field (Magnavox; Jensen).

MISCELLANEOUS.

3 terminals (2 input, 1 earth); 2 small insulating bushes (for input terminals); 1 large insulating bush (for 230v. input cable); 1½doz. assorted nuts and bolts; 1 coil push-back wire; 1 doz. solder tags; length 3 core power flex, with plug.

The Super-Quality Six

(*Continued from page* 38)

aerial sections in turn, adjusting each until volume is loudest.

Fitting A.V.C.

It is simple to fit delayed automatic volume control to this set, the only additional components required being two .1 mfd. fixed condensers, two 1 megohm resistors, one .5 megohm resistor, and a .00005 mfd. fixed mica condenser.

As shown in the sketch, automatic volume control is obtained from the second diode plate of the 55. A portion of the r.f. voltage applied to the detecting diode is passed through a .00005 mfd. fixed condenser to the second diode plate, which is connected through a .5 megohm resistor to earth. The resulting voltage drop across this resistor is applied to the grids of the 58's to provide automatic volume control. The 1 meg. resistors are included merely for decoupling purposes, while the .1 mfd. condensers are necessary to isolate the r.f. secondaries from earth and to permit the earthing of the first two sections of the gang.

HYGRADE
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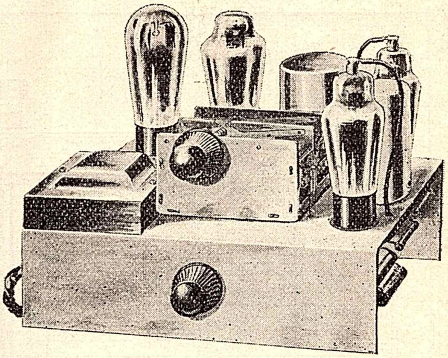
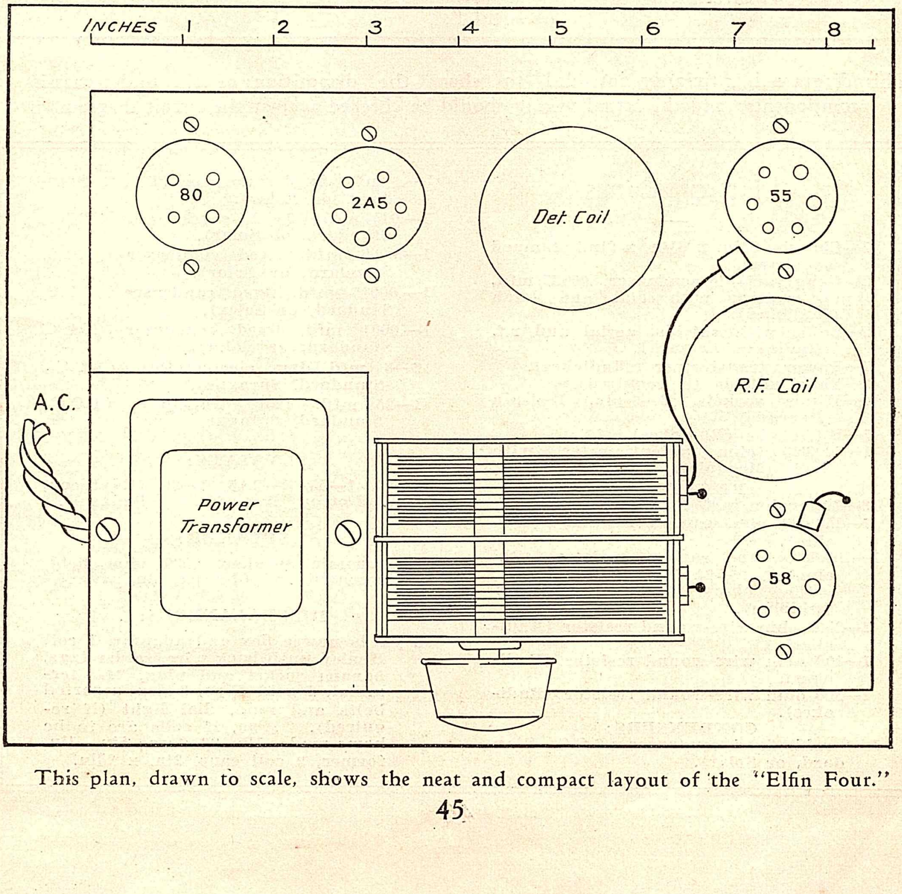
The "ELFIN FOUR"



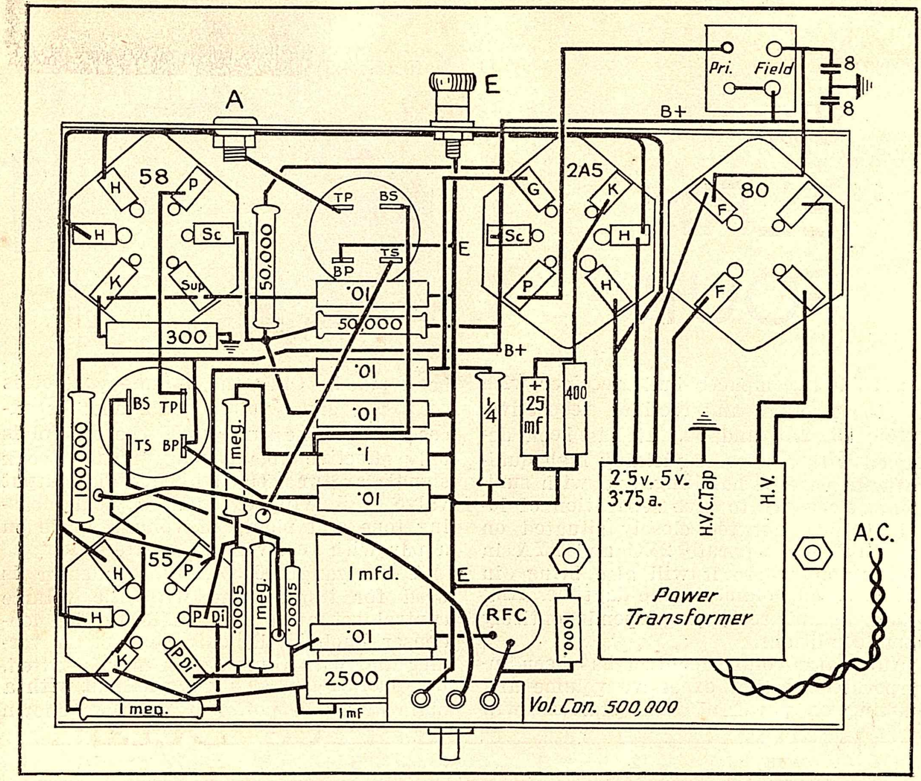
THIS is a compactly-built receiver with three valves and rectifier, respectively 58, 55, 2A5 and 80. It has been designed with a view to yielding high quality with ease of handling, and with sufficient selectivity to give separation of local stations not too closely situated on the band—to separate 2YC and 2YA in Wellington, where it will also bring in 3YA at good volume in the daytime. Any other distant reception depends entirely upon conditions.

Automatic volume control has been incorporated so that excessive volume and blasting on powerful local stations will be avoided. Once the volume control is set for a given volume, it cannot be exceeded. At the same time, the control is only effective upon strong signals—weak signals are unaffected by it. The output valve, 2A5, will be found to yield pleasing tone and plenty of volume, quite on a par with receivers of greater size.

A two-gang .00035 mfd. condenser is used for tuning, and with the volume control set at a suitable level, the condenser knob is the only control. A vernier dial with illumination may be fitted, but operation is easily carried out with a plain dial. The power transformer shown



This plan, drawn to scale, shows the neat and compact layout of the "Elfin Four."



This diagram is primarily intended to show the disposition of the under-chassis components, and the actual wiring should be checked against the circuit diagram.

List of Parts

1—Chassis, 8½in. x 6½in. x 2in., stamped as shown.
2—Gang variable condenser, .00035 mfd. per section, with dial and knob (Radiokes).
2—Coils, with shields, aerial and r.f. (Radiokes, Lekmek).
1—Power transformer (Radiokes).
2—Valve shields (if required).
4—Wafer sockets, 3—6-pin, 1—4-pin (Renrade).
1—R.f. choke (Radiokes).
1—500,000 ohm potentiometer, with knob (Marquis).

RESISTORS:

3—1 megohm carbon resistors (Ohiohm)
1—250,000 ohm carbon resistor (Ohiohm).
1—100,000 ohm carbon resistor (Ohiohm).
2—50,000 ohm carbon resistors (Ohiohm).
1—2500 ohm wire-wound resistor (Radiokes).
1—400 ohm wire-wound resistor (Radiokes).
1—300 ohm wire-wound resistor (Radiokes).

CONDENSERS:

1—1 mfd. fixed condenser (T.C.C., Standard, or Solar).
1—.1 mfd. fixed condenser (T.C.C., Standard, or Solar).
5—.01 mfd. fixed condensers (T.C.C., Standard, or Solar).
1—.0005 mfd. fixed condenser (T.C.C., Standard, or Solar).
1—.00015 mfd. fixed condenser (T.C.C., Sandard, or Solar).
1—.0001 mfd. fixed condenser (T.C.C., Standard, or Solar).
2—8 mfd dry electrolytics (T.C.C., Standard, Sprague).
1—25 mfd. (25v. working) (T.C.C., Standard, Sprague).

VALVES:

1—58, 1—55, 1—2A5, 1—80 (Raytheon, Radiotron, Nat. Union, Tungsol).

SPEAKER:

1—Dynamic speaker, 2500 ohm field, to match 2A5 (Jensen, Magnavox).

MISCELLANEOUS:

3 yards power flex and adaptor, 1 coil Henley push-back wire, solder tags, banana socket and plug, "E" terminal, 2 grid clips, 2 doz. assorted bolts and nuts, dial light (if required). Also, if coils are to be home-made, ¼lb. 36 d.s.c., 5in.—1in. former, 2 coil cans, 2in. x 2¾in.

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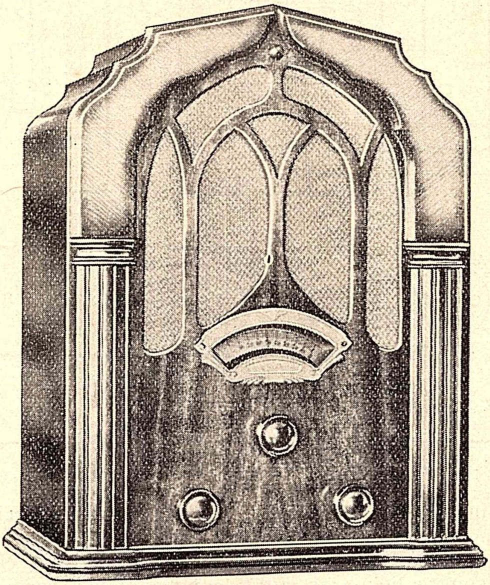

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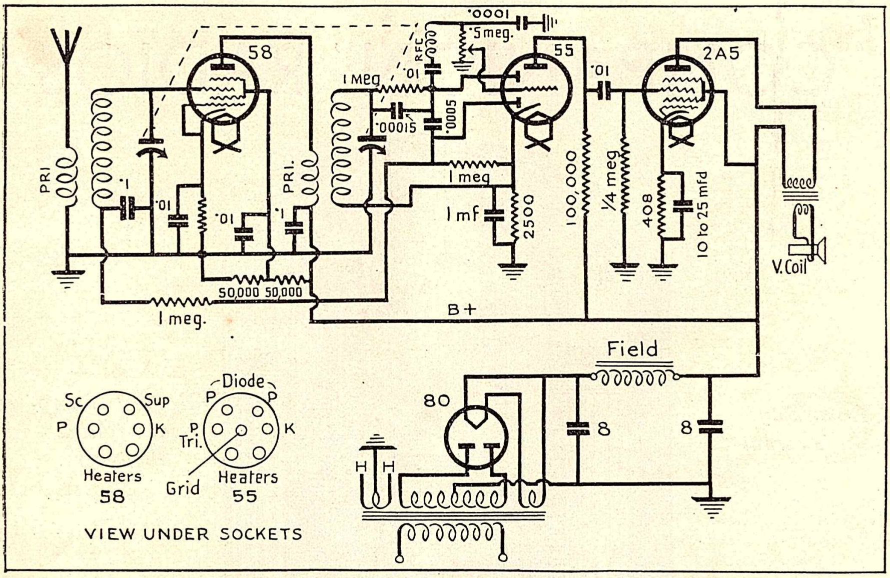
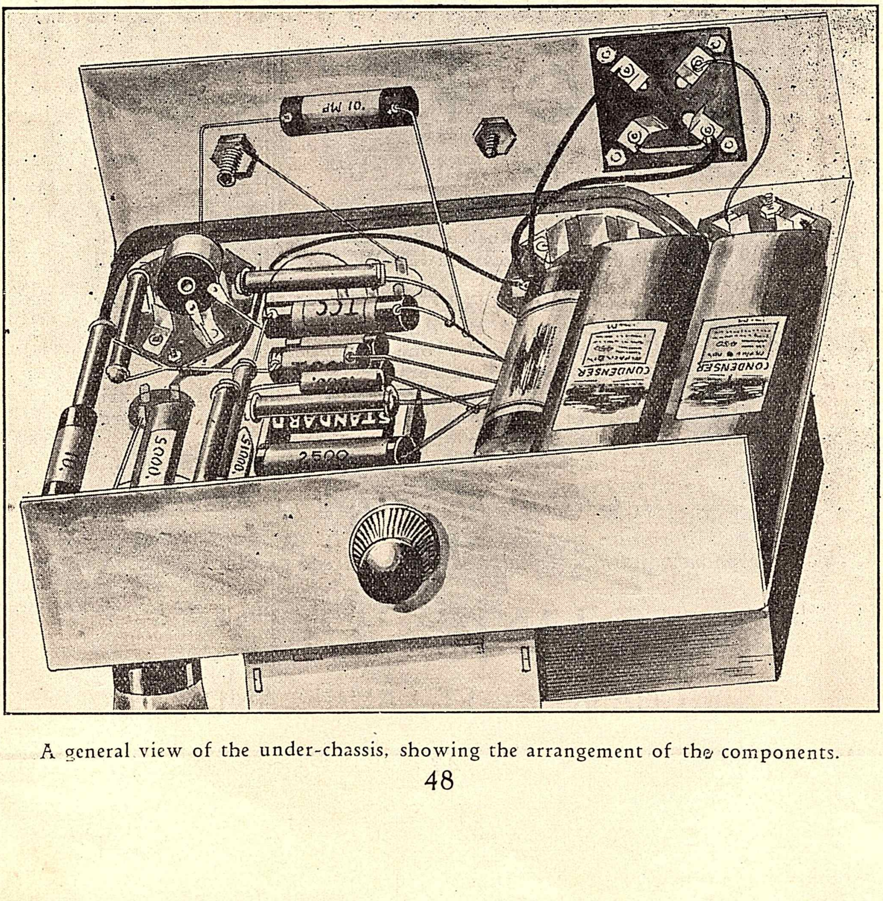


The circuit of the "Elfin Four," which employs automatic volume control.

measures 3½in. x 3in., and allowance should be made on the chassis for a larger size unless standing upright. In the experimental model a square hole was cut for the lower half of the winding to come under the chassis. The dimensions of the chassis are 8½in. x 6½in. x 2in.

Valves are kept close to the corners, leaving ample room for coils. There

(*Continued on page* 50).



A general view of the under-chassis, showing the arrangement of the components.

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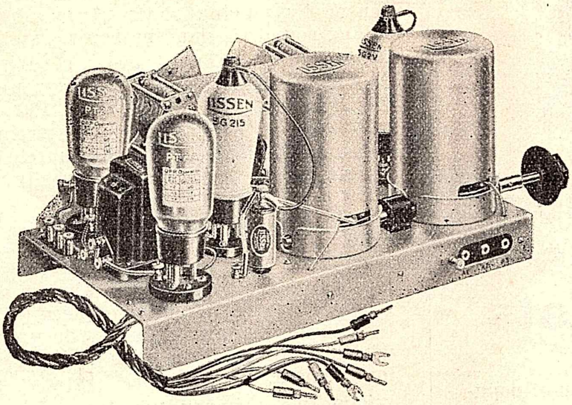

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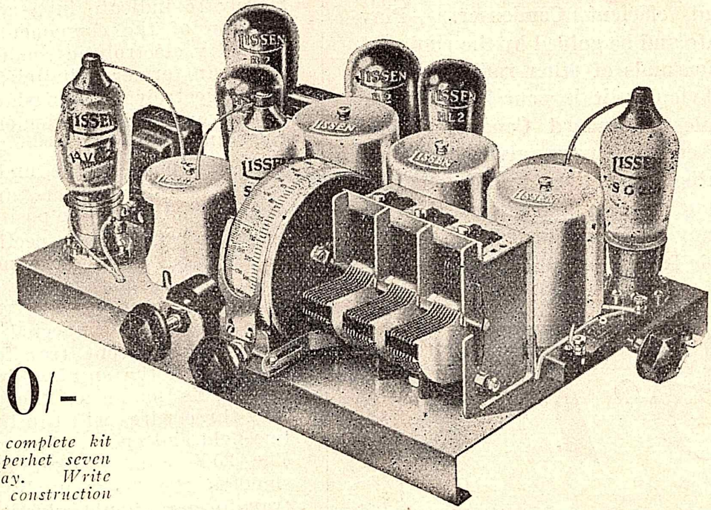

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might be found room for wet electrolytic condensers in place of the dry ones which are placed underneath. If stator connections of the tuning condenser come too close to the transformer, raise the condenser by placing short pieces of brass tubing round the holding screws.

The coil cans used are 2in. diameter and 2¾in. high, the coils being wound on 1in. formers 2½in. high, with 160 turns of 36 d.s.c., commencing ¼in. from the bottom. Similar coils ready matched for ganging may be purchased ready-made, but for local purposes they may be sufficiently accurate if care is taken to have exactly the same number of turns on each secondary, that each occupies the same length on the former, and that the two formers are cut from one piece so that the diameters are equal. Secure the windings in position with a little celluloid cement.

The two primary windings are of 36 d.s.c. for the detector coil and 32 d.s.c. for the r.f. coil, each of 55 turns tapped at 30 turns and the end brought through the base. Each is wound on a paper tube to just slip inside the 1in. former.

The taps will permit of greater selectivity if found necessary. All connections to coils are made under the chassis. If you make your own coils, glue them to a circle of card which may then be punched to take screws holding the can.

The Diagrams.

The perspective view speaks for itself, and the view of the underside is intended merely to indicate in a general way the position of the components. The two 8 mfd. dry electrolytic condensers are over the transformer windings, with the 25 mfd. electrolytic alongside. A piece of tape over the large condensers will hold them in place.

In the plan of the under-chassis, the two 8 mfd. condensers are only shown diagrammatically, the positive end of each being connected to respective contacts on the speaker socket—the negative end of each to the chassis, or common earth wire in the centre. The returning "B+" wire is shown connected to the "B+" end of the output transformer primary situated on the speaker, but if this connection is made on the speaker itself, only three wires will run to the speaker—two field and one to plate end of primary. The 2500 ohm speaker field effectually smooths the "B" supply. The power transformer should give an initial voltage of at least 360.

Valve shields can be used, though it was found that they are not necessary. The wire from the volume control to detector grid should be kept well spaced away from other wiring.

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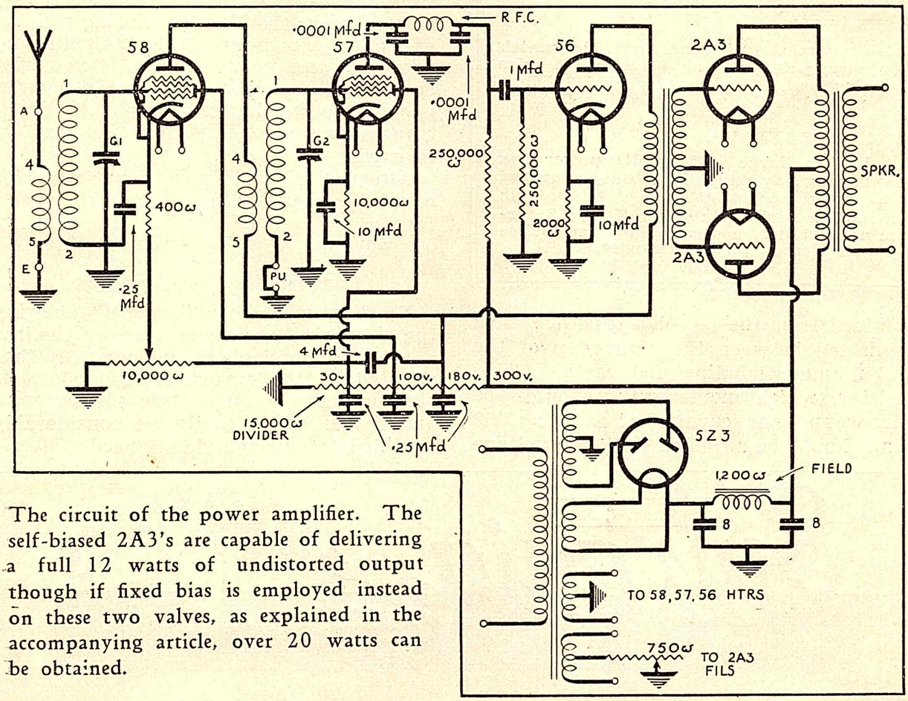
The "Public Address" 12-Watt Amplifier

THIS amplifier has been designed primarily for dealers and servicemen interested in public address work. The push-pull 2A3's are capable of delivering a full twelve watts of undistorted output, while the quality of tone is a reveation to those accustomed to the reproduction of a single pentode.

To increase the utility of this amplifier, a 58 r.f. stage, feeding a 57 power detector. has been added to provide broadcast reception as well. The pick-up is connected to the earthed end of the detector coil secondary, as shown. The volume on radio is controlled by the 10,000 ohm potentiometer in the cathode circuit of the 58, and on records by the control which is almost invariably found built into the pick-up itself.

The 57 is resistance capacity coupled to a '56, which as the driver is capable of swinging the grids of a pair of 2A3's to the maximum permissible load without distortion. Bias for these two valves is



The circuit of the power amplifier. The self-biased 2A3's are capable of delivering a full 12 watts of undistorted output though if fixed bias is employed instead on these two valves, as explained in the accompanying article, over 20 watts can be obtained.

List of Parts.

1—Chassis, 10in. x 14in. x 2in.
1—Power transformer, (Radiokes 1-32).
1—push-pull input transformer (Ferranti AF5C).
1—2 gang variable condenser, with suitable dial and dial light (2.5v. bulb). (Radiokes).
2—Shielded coils, aerial and r.f. (Radiokes, Lekmek).
7—Wafer sockets, 3—4 pin, 2—5 pin, 2—6 pin (Renrade).
2—valve shields, type 58.
1—10,000 ohm potentiometer, with insulating bush and knob (Marquis).
1—r.f. choke (Radiokes).

FIXED CONDENSERS.

2—.0001 mfd. (T.C.C., Standard or Solar).
1—.1 mfd. (T.C.C., Standard or Solar).
4—.25 mfd. (T.C.C., Standard or Solar).
1—4 mfd. dry electrolytic 200v. working (T.C.C., Standard, Sprague).
2—10 mfd. dry electrolytics, 25v. working (T.C.C., Standard, Sprague).
2—8 mfd. wet electrolytics, 500v. working (T.C.C., Standard, Sprague).

FIXED RESISTORS.

1—400 ohm carbon (Ohiohm).
1—2000 ohm carbon (Ohiohm).
1—10,000 ohm carbon (Ohiohm).
2—250,000 ohm carbon (Ohiohm).
1—750 ohm wirewound (Radiokes).
1—15,000 ohm voltage divider (Radiokes).

VALVES.

1—58, 1—57, 1—56, 2—2A3's or 45's, 1—5Z3 (Raytheon, Radiotron, Nat. Union, Sylvania, Tungsol).

SPEAKER.

1—Dynamic, 1200 ohm field, to match push-pull 2A3's or 45's, with 5 wire flex and UY plug (Jensen D8, Magnavox).

MISCELLANEOUS.

2 bushes, large and small; power flex and plug; 2 grid clips; Bulgin output plug and socket (230v. a.c. to motor); mounting strip (Radiokes T-50); 2 terminals; 2 doz. assorted nuts and bolts; 1 coil Henley push-back wire.

obtained from the 750 ohm resistor shown connected between the centre-tap of the 2A3 filament winding and earth. This resistor, which incidentally should be wire-wound and capable of carrying 150 m.a., should be adjusted until the voltage drop across it is exactly 62 volts. About 700 ohms is the correct value for this.

The speaker employed should have a 1200 ohm field and be provided with an input transformer to match push-pull 2A3's. If at all possible, a 10-inch concert dynamic speaker should be used, as it is the only type of speaker which can handle such a huge output and still preserve the quality.

All values, together with the voltages on the voltage divider, are marked on the circuit diagram, so no further explanation is needed here.

45's Can Be Used.

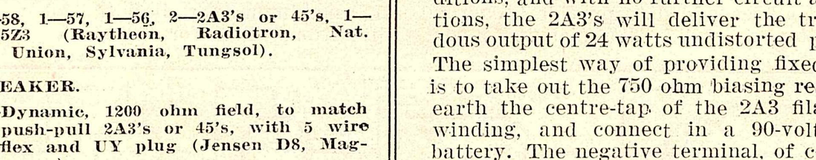
The new 2A3, with its multi-filamentary cathode, is a high efficiency valve, but as it is rather expensive in comparison with its older brother, the 245, many will prefer to use the latter valve. Of course, some sacrifice in power output must be expected, but at the same time a pair of 45's plugged in in place of the 2A3's with no circuit alterations, give surprisingly good results. Though they are slightly over-run, yet this is largely compensated for by the fact that they operate in this circuit as "prime class A" amplifiers.

In cases where even greater output is wanted than the self-biased 2A3's can provide, it can be easily obtained by incorporating a fixed bias of 90 volts on the output valves. Under these operating conditions, and with no further circuit alterations, the 2A3's will deliver the tremendous output of 24 watts undistorted power. The simplest way of providing fixed bias is to take out the 750 ohm biasing resistor, earth the centre-tap of the 2A3 filament winding, and connect in a 90-volt "B" battery. The negative terminal, of course, is connected to the centre-tap of the input transformer secondary, and the positive to earth.

Alternatively, the necessary fixed bias could be provided by a separate transformer and a triode such as the 201A or 56, working as a half-wave rectifier.

Constructing the Amplifier.

No diagrams other than that showing the circuit will be given, because the layout is not particularly important. That adopted in the experimental model is shown in the accompanying photographs, and it can quite easily be considerably modified to suit individual needs.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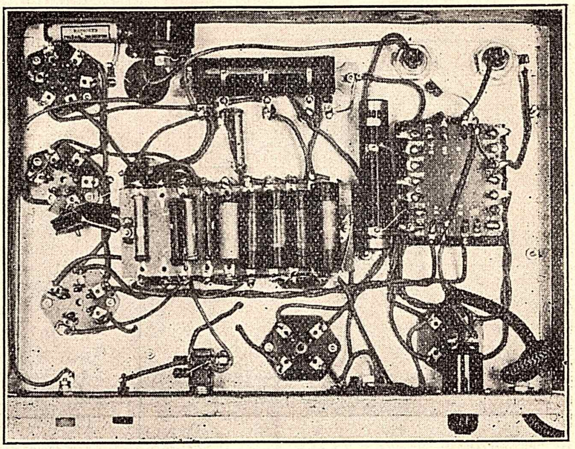


An under-chassis photograph of the experimental model. As explained in the text, the layout is not particularly important, and can be considerably modified to suit individual requirements.

It will be noticed that a closed circuit jack has been used for connecting the pick-up in circuit. However, this is entirely a matter of convenience. Two terminals with a jumper connected between when the amplifier is being used for broadcast reception are just as effective.

It will also be noted from the under-chassis photograph that a special plug and socket have been bulit-in to supply the mains voltage to the gramophone motor. This again, is also purely a matter of convenience, and can quite easily be omitted if the current for the motor is drawn from another source.

The "Compact" Crystal Receiver

THIS crystal set will be found useful to the experimenter for checking-up on the local, and will also serve as an auxiliary receiver for use when retiring for the night at an early hour.

Selectivity with hook-up "A" is sufficient to separate 2YA and 2YC, or two other locals similarly separated. Hook-up "B" is the conventional circuit, with poor selectivity but slightly more volume.

The Construction Outlined.

A one-pound tea-tin measuring about 4in. x 3in. is cut down to a height of 4½in. to serve as a container. Tin is not a good metal to have close to a tuning coil, but if the latter is kept small in diameter and centralised in the tin, no harmful effect is noticeable.

The semi-variable compression type condenser (6) has a capacity of approximately .00035 mfd. It is screwed to a strip of wood about 1in. x 3/8in. and to the top edge of this is secured the tuning-coil, using a couple of drawing pins or other convenient method. Below this is mounted a permanent crystal such as the "Griphco."

At the bottom of the can below the condenser knob is a small 'phone jack into which the 'phone plug is inserted. At the bottom left is an earth terminal (5), and at the top right is a banana socket to take a corresponding plug to the end of the aerial. A few inches of copper wire are connected to the earth terminal, and to this is joined the earth end of each coil.

The secondary coil must not exceed 1½in. diameter, and for a .00035 mfd. condenser will have 75 turns of 32 gauge enamelled wire close wound. The primary coil slips inside the secondary and can be of 1¼in. diameter if this leaves sufficient room for the winding of 50 to 70 turns of 36 gauge enamelled wire; the nearer the listener to the less powerful station, the fewer turns will be required, and selectivity thus gained.

One end of the primary connects direct to the aerial socket, the other end (3) to the earth connecton (5). The end (1) of the secondary connects to one end of the crystal (4), and end (2) to earth. Ends 1 and 2 also connect to their respective terminals of the condenser. The other end of the crystal connects to the insulated spring of the 'phone jack, and all connections are then complete.

Holes for the tuning condenser shaft, jack, and earth and aerial terminals are drilled in the container, and the strip of wood with condenser, coil and crystal attached, is placed inside, and secured

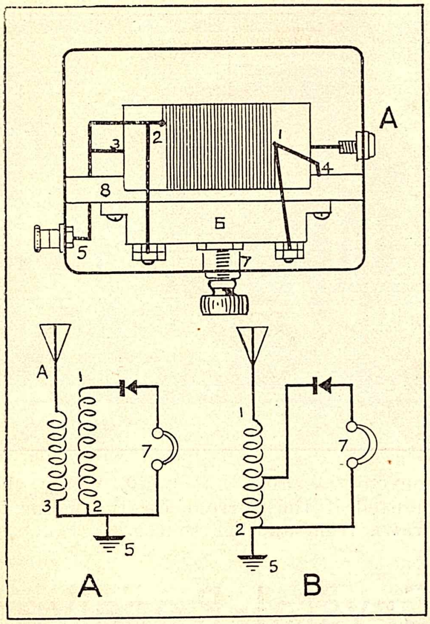
List of Parts

1—metal container (see text).
1—.00035 mfd. max. semi-variable compression type condenser.
1—banana plug and socket.
1—terminal, marked "E."
1—permanent crystal detector.
1—'phone jack and plug.
1—2in. length former, 1½in. diam.
1—2in. length former, 1¼in. diam.
Small quantities 32 gauge and 36 gauge enamelled wire.
Coil Henley push-back wiring.

with fine brads through holes punched in the tin. However, before this is fixed in place, the jack and earth terminal should be mounted, with the connecting wire attached to each.

The foregoing describes the method of connecting for circuit "A," but if only the main station is to be heard, circuit "B" may be used, dispensing with the primary coil. In this case the aerial is connected direct to the end (1) of the coil, and the crystal to a tap at the centre of the coil. All other connections remain the same. Circuit "A" can be made into circuit "B" at any time by transferring the aerial to (1), except that the crystal will not be connected to the centre-tap. If desired, two aerial sockets could be provided, one connected to each coil, giving choice of either hook-up.

A one-inch coil of 36 gauge enamelled wire, close-wound to a length of 7/8in., is a good secondary for a .00035 mfd. condenser. The primary may be of the same wire, wound to a length of ¾in. or a little less.



Above: The layout and wiring diagram. Below: Circuit "A" is more selective, though gives slightly less volume than circuit "B," which should be used only when there is no likelihood of interference between two powerful local stations. The semi-variable compression condenser employed for tuning should be connected between "1" and "2" in each case, as shown in the layout diagram.

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The "International" All-wave Superhet

WITH the introduction on the market by the leading Australian radio manufacturers of all-wave coil assemblies, combination broadcast and short-wave receivers are fast becoming popular. Several fine kit-sets are now available, and of these we have selected the Radiokes "International" all-wave superhet for description in this year's "Radio Guide." This set covers a tuning range of 15 to 550 metres in four bands, and a turn of the switch is all that is necessary to pass from one band to another.

The circuit is shown on the next page. A 56 is employed as separate oscillator, a 57 as mixer (or modulator), 2—58's as I.F. amplifiers, a 55 as diode detector and first audio valve, and a 2A5 as output pentode. The rectifier is an 80.

The all-wave coil assembly supplied with the kit is totally self-contained in an aluminium box, in which is also mounted the aerial coupling condenser for short-wave reception, the wave-change switch, and the padding condenser.

Circuit Pointers.

The output of the 56 is fed to the 57 modulator through the latter's suppressor grid. An auxiliary 23 plate midget condenser is automatically switched in the circuit for short-wave work, and provides a useful vernier tuning control. Two 58 I.F. amplifiers are employed, necessitating three I.F. transformers, which are of the latest ar dielectric type. Thus the receiver is capable of tremendous gain, but despite this, background noise on both the broadcast band and on short-wave is remarkably low. Adequate stability has been ensured by generous filtering in the plate and screen leads.

Back bias has been employed for the 2A5 output pentode, the necessary voltage being obtained from the voltage drop in the 250 ohm resistor connected between the high voltage centre-tap and earth. It should be remembered that with this arrangement, the negative lead of the electrolytic condenser on the rectifier side of the speaker field should not be earthed.

The power transformer has a secondary rated at 385 volts each side of the centre-tap, at 75 milliamperes. Three filament windings are provided—a 5 volt 2 amp. winding for the rectifier, a separate 2.5 volt winding for the 2A5, and another similar winding for the remainder of the valves in the set.

Radiokes Kit of Parts.

1—stamped and drilled chassis.
1—2 gang .00037 mfd. condenser, with drum dial.
1—all-wave coil assembly.
2—4 pin, 1—5 pin, 5—6 pin wafer sockets.
1—power transformer.
1—23 plate midget condenser.
3—air-dielectric 460 k.c. I.F. transformers.
1—terminal strip.
4—r.f. chokes.
5—type 58 valve cans.
1—block condenser (4 x .25 and 1 x .5).
1—.001 mfd. mica condenser.
1—.0005 mfd. mica condenser.
1—.00025 mfd. mica condenser.
1—.0001 mfd. mica condenser.
1—.01 mfd. mica condenser.
6—.1 mfd. tubular condensers.
2—8 mfd. electrolytic condensers.
1—10,000 ohm potentiometer.
1—250 ohm pigtail resistor.
2—400 ohm pigtail resistors.
1—5000 ohm pigtail resistor.
1—100,000 ohm pigtail resistor.
3—20,000 ohm pigtail resistors.
1—.5 megohm grid leak.
1—1 megohm grid leak.
1—.05 megohm grid leak.
1—15,000 ohm voltage divider.
Screws, wire, sundry hardware, etc.

ADDITIONAL PARTS REQUIRED, BUT NOT INCLUDED IN KIT.

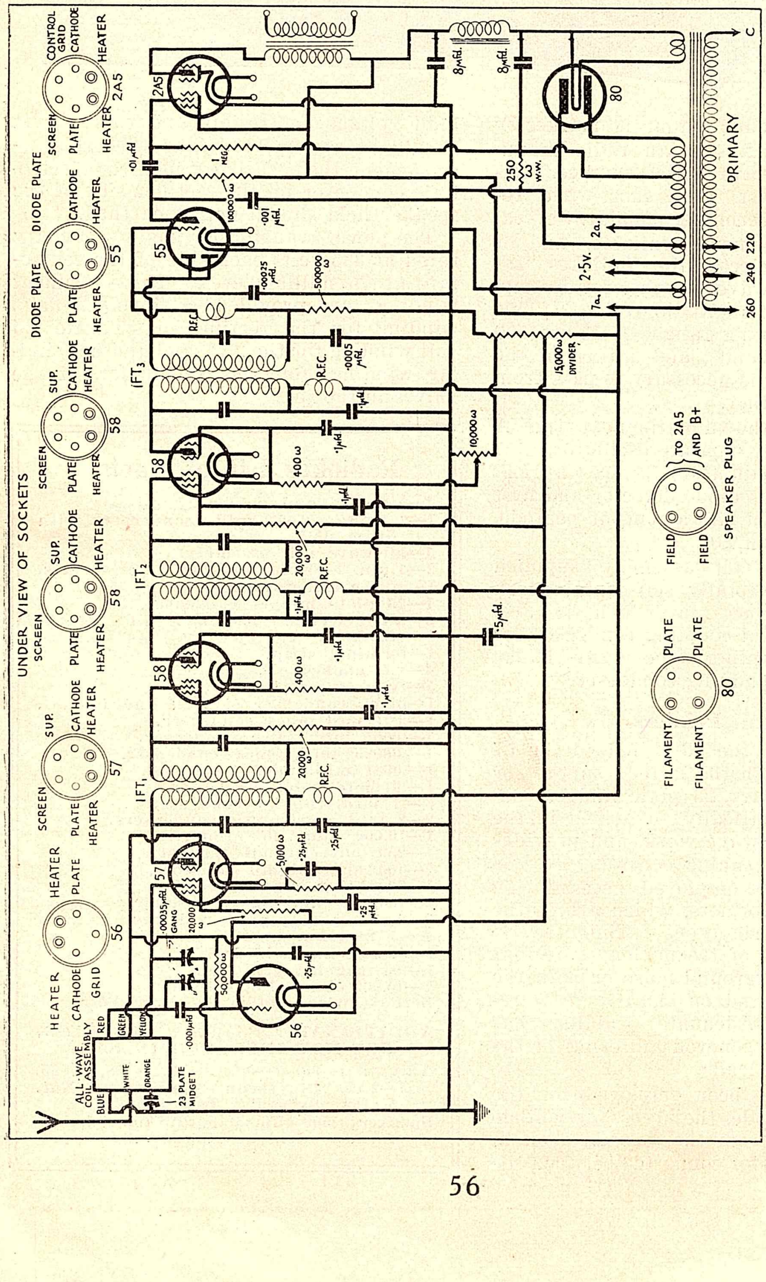
Valves: 1—80, 1—56, 1—57, 2—58, 1—55, 1—2A5 (Raytheon, Radiotron, Nat. Union, Sylvania, Tungsol).
Speaker: 2500 ohm field, 2A5 input transformer (Jensen, Magnavox).

Components in the Kit.

The Radiokes "International" superhet kit-set comes to the constructor complete to the last screw and nut. The steel chassis is already stamped and drilled to take the components. Included in the kit is an instruction sheet showing the circuit and under-chassis layout diagrams of the receiver and also giving some advice on assembly and wiring. The information supplied is quite sufficient to enable the average home constructor to assemble the set successfully, but the following hints will no doubt prove valuable.

Mounting the Components.

After the kit has been unpacked, the first task is to mount the six valve sockets on the steel chassis, in the positions indicated on the under-chassis diagram. Looking at the front of the chassis, right way up, the 56 valve socket should be so mounted so that the heater terminals are nearest to and parallel with the left top edge of the chassis. The socket next to this—for the 57—should be mounted in the opposite direction, i.e., with the heater terminals nearest the right-hand edge of the chassis.



The circuit of the "International" superhet has several interesting features. A separate 56 is employed as the oscillator, which is coupled to the 57 modulator through the latter's suppressor grid. Two 58 I.F. amplifiers are used, necessitating three intermediate frequency transformers. These are of the air-tuned type, which provide better amplification, higher selectivity, and preserve their characteristics longer than the older type with mica dielectric condensers. The 2A5 output pentode is "back-biased" by the voltage drop through the 250 ohm wire-wound resistor connected between the centre-tap of the high voltage secondary and earth.

The three sockets along the back of the chassis, i.e., for the two 58's and the 55, should be mounted similarly to that for the 56. Finally, the heaters of the 2A5 sockets should be nearest the front of the chassis, and the filaments of the 80 placed likewise.

Now mount the three intermediate frequency transformers, being careful to take the coil leads through their correct holes, as shown in the under-chassis layout diagram included with the kit. The speaker socket, and the aerial and earth terminals can also be mounted.

The power transformer comes next. Mount this so that the 2.5 volt 2 amp. lugs are nearest the right-hand side of the chassis, looking down on top of the set. Then come the two electrolytics. The two leads from each of these condensers should be passed through the holes provided. Notice that the negative lead of one electrolytic condenser, i.e., that on the rectifier side of the field, is not earthed.

Mounting the Gang.

Now solder a lead to each fixed plate lug underneath each of the two sections of the gang, and then mount the gang itself by means of the bolts provided. Note particularly that under each of the mounting lugs on the gang, a rubber cushion, through which the mounting bolt passes, should be placed.

The 23 plate midget condenser and the volume control potentiometer should then be mounted on the right and left-hand sides respectively of the hole drilled to take the shaft of the all-wave assembly. The shaft of the potentiometer should be insulated from the chassis by means of the insulating washers provided.

The heater wiring may now be put in. The extreme lugs of the 2.5 volt 2 amp. winding should be connected to the heater terminals of the 2A5 socket by means of a pair of twisted leads. Similarly the filament of the 80 should be wired to the correct lugs of the 5 volt winding. Two further twisted leads should now be taken from the 2.5 volt 8 amp. winding to the heater terminals of the 55. Another two twisted leads should also be run from these terminals to the corresponding terminals of the 58. In the same way another pair of leads is taken on to the next 58; then a further pair from this valve to the corresponding terminals of the 57; and, lastly, another pair of twisted leads is taken on from the 57 heaters to those of the 56. The heater wiring is now complete. The remainder of the power transformer wiring should be completed as far as possible.

Next, wire up the three intermediate frequency transformers, the r.f. chokes, earth lines, etc. The wiring should now be completed as far as possible without the remainder of the components.

Then mount the voltage divider, and connect the end nearest the front of the chassis to the nearest convenient earth point. Then wire the two voltage divider taps. Now mount the condensers and resistors on the bakelite terminal strip according to the diagram provided with the kit, and then attach to the chassis the brackets provided for mounting the strip. Next place the strip in position and wire it up, afterwards bolting it down to the brackets. The block condenser should now be mounted and the wiring completed as far as possible.

Mounting the All-wave Coil Assembly.

The last big task is the mounting and wiring of the all-wave coil assembly. The various connections from it can easily be traced out with the aid of the circuit and under-chassis diagrams.

Lastly, pass the power flex through the rubber grommet provided for it at the right-hand end of the chassis, and connect it up to the primary of the power transformer. The red wire should be attached to "240," the black to "C" and white (or other colour) to the nearest convenient earth point.

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After the wiring has been carefully checked over, the valves can be plugged in, the shields slipped over them, the aerial and earth connected up, and the loudspeaker plugged in. Then turn the set on, at the same time watching the rectifier for any blue glow or flashes. If these occur, switch off the power and look for short circuits. If, on the other hand, the filaments heat up slowly to a dull red, and "B" voltage is present, the dial can be rotated and stations should be tuned in.

The Procedure for Lining Up.

As there is no r.f. stage in this receiver, the lining up is quite simple. Set the two trimmers on the gang and the padder about two-thirds out. Then tune in a station on a low wave-length, and adjust the volume control so that signals are faint. The aerial trimmer, i.e., that on the left-hand section looking at the front of the set, should now be adjusted for best results.

Now tune in a station at the other end of the dial, say 2YA or 3YA, and adjust the padder for best results. Do not touch the trimmer on the aerial section—this is adjusted only on the lower wavelengths. As the padder screw is turned, rock the dial backward and forward until the volume is loudest. The padder condenser adjustment is made by turning the receiver upside down, and adjusting the padder screw, i.e., the condenser screw in the all-wave coil assembly nearest the front of the chassis.

Then turn back to the low wavelength station and check the aerial trimmer of the gang, and finally back once more to the other station and check the padding.

Tuning on the Short-waves.

The waveband from 15 to 200 metres is covered in three bands—15 to 35 metres; 35 to 90 metres; and 90 to 200 metres. With the wave-change switch turned to the extreme right, the set is working on the 15 to 35 metre band, and to the extreme left, on the broadcast band. The aerial coupling condenser, which is behind the padder, should be adjusted for best results on the short-wave band.

The right-hand control, which is an auxiliary trimming condenser, is automatically switched into circuit on the three short-wave bands, and should be adjusted on each station for best results. This control is automatically switched out of circuit on the broadcast band.

A Fine Performer.

The "International" is capable of giving a very fine performance on both the short and broadcast bands. On the short-waves the efficiency is excellent, and the set is capable of giving real entertainment, at more than sufficient volume, from short-wave stations all over the world; while on the broadcast band, Australia, Japanese, and American stations can be tuned in at splendid volume.

Section 2.

DESIGNING AERIALS AND EARTHS

AERIALS FOR BROADCAST RECEPTION

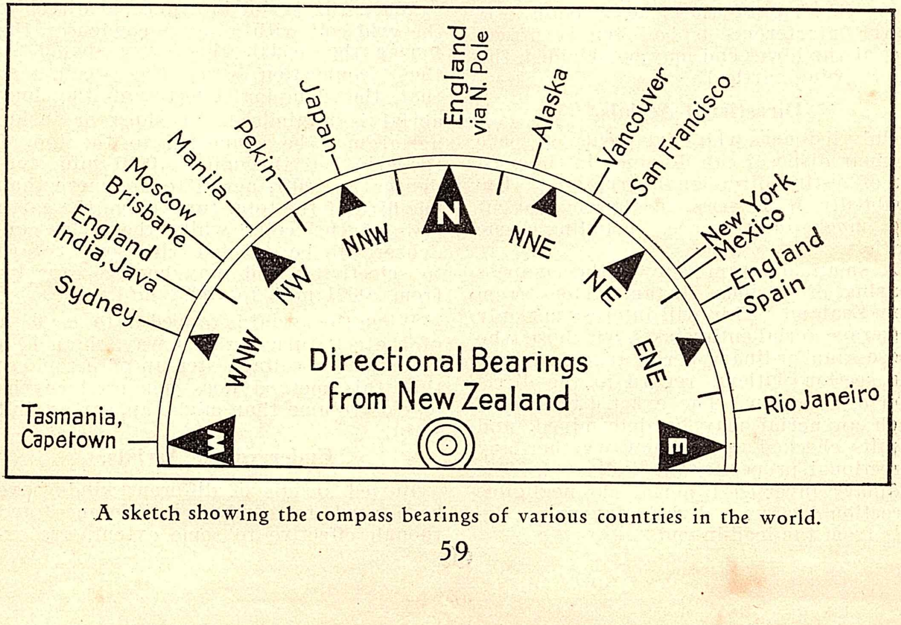
THE reception of ordinary broadcast signals from distances up to a couple of thousand miles presents a very simple problem when a sensitive receiver is used, and conditions are good.

Under such circumstances almost any few feet of wire will bring in the stations at night-time. But ideal conditions are scarce, and if the old bugbear static is to be minimised, a reasonably good aerial should be provided. The keen DX hunter, stretching out after European stations previously unheard in this country, will do everything possible in the way of providing an aerial giving both length and height. Still, it must not be inferred from this that real DX hunting cannot be carried out successfully on the average aerial, because it can, when the location is good and conditions are favourable.

Care should be taken in the selection of the position of the poles, allowing plenty of spread for the stays. Many poles are rendered unsafe through being placed too near the back fence, rendering the pull of the back stay almost ineffective— especially because it is not examined and tightened up at frequent intervals. Some constructors have placed a pole actually against a fence and passed the stays over "cross-trees" half way up the pole, fastening the lower end of each stay to the pole. This system is entirely wrong, and cannot prevent the pole bending over with the pull of the aerial, and perhaps finally breaking off near the ground. It is much better to have an aerial a few feet shorter, and safe, than cause the anxiety occasioned by a pole that is ineffectively backstayed.

Near Powerful Locals.

Under conditions around busy centres, height, but not too great a length, is the best proposition, say 60 or 70 feet from the receiver to end of the flat top. Height and length are both difficult to secure on small building sections, and the best must be done under the circumstances. Too long an aerial is unselective, and may give little or no advantage on general reception. Where space is very limited, a short aerial of two wires may be used. The wires are not joined at the far end, but join at the top of the lead-in. The



A sketch showing the compass bearings of various countries in the world.

wider apart the two wires are placed, the greater will be the gain, so make the distance six to ten feet if possible. Placing wires in parallel in this way reduces selectivity but increases volume, but where the length is available, the single wire is the best.

The best wire for the aerial itself is black enamelled 7/22 gauge. When a joint has to be made, each wire should have the end scraped clean, and "tinned" with solder, ready for joining. The joint should be protected, either with adhesive tape or duco enamel. Stranded galvanised wire similar to that used for clotheslines, but of better quality, is the best for stays. There is no necessity to put insulators in the stays—if there were, then the pole, especially if of iron, should also be insulated by standing it on an insulating block.

If a galvanised pulley or "block" is used for the halyard to run through, great care should be taken to see that this is securely fastened to the top of the pole. All the weight and pull of the aerial has to be sustained by the fastening of the block, and in the event of it giving way, the only way of replacing it may be by taking the pole down. Secure the block as near as possible to the top of the pole—an inch or two below, not a foot or more. The same remark applies to the top set of stays.

In some situations a T aerial is found to suit best, and where this type is adopted, the lead-in must be attached to the exact centre of the horizontal wire.

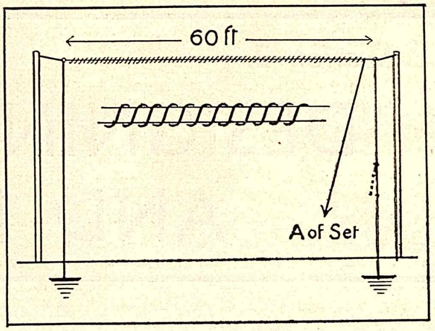
One-Pole Aerials.

Where space is too limited to allow of suitable distance between two poles, it is a good proposition to put up one high pole, securely stayed, and have an almost vertical and non-directional aerial running from the top of the lead-in point. If power interference is bad, ten or fifteen feet at the lower end may be shielded, the shield being earthed.

Directional Aerials.

Only listeners who have plenty of space at their disposal can do much in the matter of testing directional reception. Undoubtedly it is possible thereby to cut out much interference, including some static.

A small diagram shows the compass bearing of various distant places from New Zealand. This will interest not only Beverage aerial enthusiasts, but those who possess an ordinary aerial placed to suit the section without regard to the direction of recepton. The exact direction of such an aerial may be determined, and results checked up to show whether any directional properties are indicated. The ordinary inverted L aerial has negligible directional effects, slightly favouring signals from the lead-in end.



Details of this experimental aerial are given on the next page.

It will be seen that an aerial pointing north-west favours one group of signals spreading over an arc of one-eighth of the circle, and an aerial pointing north-east favours a similar wide group. These two directions are at right angles. At certain times, particularly in winter, when the South Pole is continuously dark, signals from the other side of the world are thought to arrive from direct south—via the South Pole, when darkness is most favourable by that route. Owners of ordinary aerials need take little heed of the direction unless a choice can be made at the time of erection. Brief particulars of the Beverage aerial will be found in the "Facts" Section. The more directional an aerial is, the less static will it pick up.

Frame aerials are highly directional, but useless for general reception unless connected to a powerful superhet.

The direction of the aerial is of no importance for ordinary reception of Australian and New Zealand stations.

When the aerial is connected direct to the grid coil with a series condenser, the longer the aerial, the lower should be the connection to the coil, so that the damping effect of the long aerial is minimised. A short or inside aerial may be connected to the top of the grid coil through a .0001 mfd. condenser; a 100ft. aerial to not more than one-fifth of the total turns from the earth ends of the coil; while the series condenser will be selected with some regard to selectivity, and may have a capacity from .0001 mfd. to .0002 mfd.

When the aerial is tapped in to one-fifth of the coil turns in this way, there is a transformer voltage step-up of 5 to 1, so that this method does not produce the loss of volume that might appear at first sight.

Underground Aerials.

Buried aerials of different kinds have been used to combat interference, and though effective to some extent, are expensive, and reduce sensitivity, although the length may be greater than that of the overhead type.

A much better and more economical proposition is to experiment with an aerial supported on insulators along the dividing fence, not more than two or three feet above the ground, and running away from the source of interference. With a sensitive receiver such an additional aerial may prove a boon in reducing background noise, local interference and static when these are in evidence. An aerial in the house basement has the same effect.

Interference.

In some situations local interference is the most troublesome problem of all, and the method of treatment will vary considerably according to the type and source of the trouble.

Shielding the lead-in about half way up from the receiver to the flat top is a good initial try-out, also testing as to whether the best effect is obtained by earthing the shielding direct, or through a fixed condenser, using a variable one to determine the best value. If the receiver is unshielded, the wiring, particularly grid leads, may pick up as much interference as the lead-in itself. In many receivers built on a metal chassis, the under side of this is the only unshielded part, and it will pay to make a test as to whether any improvement is noticed when the under side of the chassis is shielded with a sheet of metal which may be aluminium, or even tin.

A properly shielded all-wave receiver can be placed two feet away from a transmitter putting out 80-metre 'phone, and receive at good loudspeaker strength on any band except 80 metres, without interference from the transmitter.

Another article deals with several types of special aerials for reducing interference.

An Experimental Aerial.

Here is an aerial working on the transformer principle that has given excellent results, according to the originator's description. There is the usual enamelled aerial wire between two poles, but each end of the aerial is earthed. Around the 60 foot flat top portion is wound, in close helical fashion, 300 feet of thin enamelled wire, one end being left open and the other end taken to the receiver.

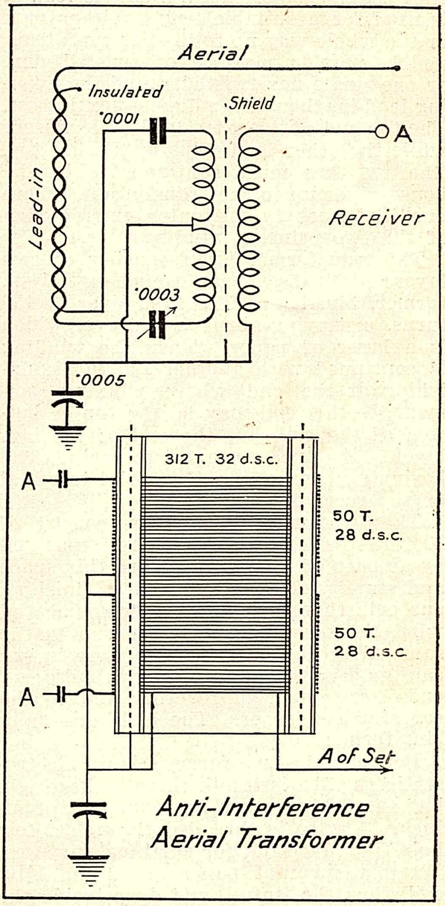
Tests are made to ascertain whether results are better with the receiver end of the main wire earthed or not. Some receivers function better without an earth connection. Ready-wound wire has been prepared by a manufacturer. Actually the winding amounts to about fifteen turns per inch of thirty enamelled wire round a 7/22 enamelled aerial, 36 turns taking one foot of wire. Better insulation than enamel on the main wire would be an improvement.

This scheme is mentioned with the idea of giving experimenters the cue to try methods somewhat off the beaten track. Sometimes merely earthing the far end of an ordinary aerial through a variable high resistance has made a marked improvement. Aerial peculiarities have to be tested to suit the location.

General Reception.

Selectivity aids in the reduction of static and interference, and sometimes the inclusion of a couple of wave-traps in series with the aerial will improve matters on a bad night; but in conjunction with tuning the aerial and cutting out the high notes with a tone control, the interference can only be minimised.

The noise level of the receiver itself is a big factor in DX reception, especially on weak signals. All possible noise should be eliminated by an occasional look-over, testing all joints, and re-soldering where



A scheme for reducing power interference picked up by the aerial.

necessary. Sensitivity is not much advantage if it only accentuates the receiver noise. Valve noise may be kept to the minimum by operating the r.f. plates at the best operating voltage, to be found by experiment. Quiet working of the early stages is essential, because of the great amplification that follows, and there are still designers of receivers who advocate using a triode valve in the first stage.

Correct by-passing to confine all radio frequency currents to their proper paths adds materially to the quietness and stability of a receiver. In a superheterodyne too much gain preceding the mixer will considerably raise the noise level of the receiver.

Interference Reducer.

This is a scheme to reduce or eliminate local interference, and has the advantage of not requiring the erection of a special aerial. (see diagram on previous page).

According to the intensity of interference usually experienced, a double lead-in is used for a suitable length, either part or the whole way up to the flat top. This double portion may be of twisted flex, or one single flex twisted round the existing lead-in, though the double flex is best. The top end of the extra lead is insulated, while the other lead joins to the flat top. The twisting must continue inside the house right up to the transformer, where one lead goes to the outer end of each of the two primary windings.

The transformer itself consists of two layers of 32 d.s.c. wire wound on a 1½in. former, 3in. long. The first layer is 156 turns, occupying about 2¼ in., over which is a layer of paper. Then the winding is continued with another 156 turns, finishing at the end where winding commenced—this end may be the top or bottom of the coil, but the end of the last layer is the one to connect to earth. The beginning connects to the aerial terminal of the receiver.

The two primary windings consist of 50 turns each of 28 d.s.c. wire, separated by a space of 3/16 inch. Mark this space and start winding at the centre, finishing one coil, then turn the former round and wind the second, which is to run in the same direction as if the two were in one continuous winding. The two adjacent ends are connected together and to the earthing condenser. The coils are on a 2in. former.

Between the two formers is an electrostatic shield of tinfoil, three inches high, but short of meeting by a quarter of an inch. A wire is threaded through a few holes in the tinfoil for earthing purposes. Wrap a sheet of paper round the 1½in. coil, then the tinfoil, and drop inside the primary former.

The whole idea in winding the coils is to make them as symmetrical as possible. Each primary should be similarly disposed in relation to the secondary.

Earthing.

Direct earthing is sometimes specified in this type of apparatus for the primary centre-tap, shield, and one end of secondary.

In many cases it will be found better to earth all these through a .0005 mfd. variable condenser, as direct earthing may prove too drastic and allow no signal other than the local to get through. By earthing through a condenser, the coupling may be varied, if necessary, to suit the occasion, and usually set at an all-round value.

Various combinations should be tried out, such as earthing the primary centres direct, and others through the condenser, and so on, and the condenser may be arranged to give a direct earth when full in.

Aerial Connections.

The actual aerial lead connects to the variable .0003 mfd. or other value condenser to balance the circuit, and the extra lead to the .0001 mfd. fixed condenser. Variable condensers used may be of the screw-down type for economy.

This type of apparatus works best when both itself and the receiver are shielded, otherwise interference is picked up by the circuit. A distinction must also be drawn between interference picked up by the flat top of the aerial, which cannot be eliminated. The ignition spark of many motor-cars appears to come within this category. Carpet-sweeper and similar interference is more easily dealt with.

AERIALS FOR SHORTWAVE RECEPTION

No matter how good the receiver, it should be backed up by a suitable aerial if optimum results are to be obtained.

Much of the noise attributed to static is produced by man-made interference from power-lines, electric machinery, and motor-car ignition. These noises are picked up chiefly by the lead-in wire, and when amplified, form a disagreeable background that is frequently sufficient to render speech unintelligible.

A little effort and experiment in cutting down noise may be equivalent to the addition of another valve to the receiver, or even better, because extra amplification of a noisy signal makes matters worse.

Although the ordinary broadcast aerial, 60 to 100ft. long, may be used for shortwave reception, it should not be taken for granted that it cannot be improved upon.

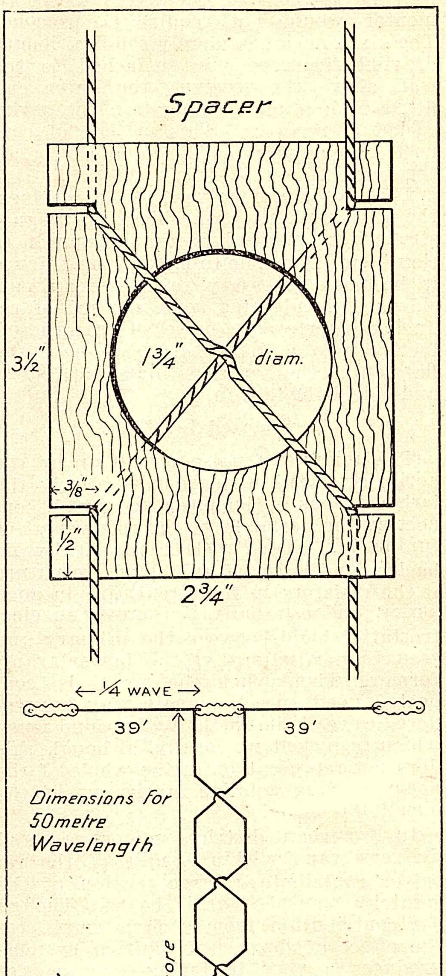
Experimental Aerials.

In an endeavour to obtain good, clear speaker reception of all main short-wave broadcast stations throughout the world, the writer, employing a five-valve 1932 Advance all-wave receiver, has done a considerable amount of experimenting with a view to eliminating the large amount of interference picked up by the aerial, fairly well situated in a Wellington suburb. The regular outside aerial used is a wire running 60 feet diagonally to a height of 45 feet, over an iron roof, but reception from this is often too noisy to stand high amplification, and in place of it the greatest improvement and simplest construction has been obtained from the use of 50 feet of bell-wire running diagonally under the floor of the house, from the receiver near the front, to the extreme back of the house, where the extra length is turned along near the back wall of the house.

The main point to observe is that the wire leads away from any point where interference may be picked up. As the exact disposition of the wire is probably immaterial, and would depend upon the space available, some type of zig-zag would suit in some cases. The wire is just hooked over an occasional nail driven into the joists. When interference background is bad on the outside aerial, the basement aerial picks up DJA, FYA, etc., in the daytime with such freedom from noise that high amplification and speaker reception is possible, still keeping clarity of speech, which would be unreadable per medium of the outside aerial.

The basement aerial ascends through a hole in the floor below the receiver, and is kept away from the lead-in of the outside aerial so that interference may not be picked up from it. This scheme is given in order to indicate one line upon which experiments may be made without much trouble or expense, where space under the house will permit.

In addition to the two aerials mentioned, the writer also has four others handy for use as conditions require. One is a picture-rail aerial round 3½ sides of the room, and this often gives better speaker reception than the outside aerial. Another consists of a wire running from the receiver half-way up the height of the room, where it branches into five separate strands of 30 d.c.c., each soldered on, each strand being about 15 feet long. A vertical lath 2ft. 7in. long is fixed to the wall at the top of the narrow side of the room, the strands being stretched on nails 6 inches apart on the two laths. An exact duplicate of this aerial is fixed at right-angles on the adjacent wall, so that directional effects



An easily-made doublet aerial for short-wave reception.

may be tested, but the average experimenter would not require the second. The sixth aerial is merely a 6-foot length of rubber-covered wire attached to the wall above the receiver, the lower end fitted with a pin to plug into the aerial socket of receiver. This method of connection is adopted as the handiest for all the aerials.

The fewer the valves in the receiver, the less can any sacrifice in signal strength be made, because the amplification is not available to make it up. Hence it becomes necessary to utilise an outside aerial, adopting some method of reducing interference noise. One most effective way of doing this is to have the flat top of the aerial as high as possible, and shield the lead-in.

Transposed Lead-ins.

The amount of noise picked up by the aerial and lead-in, more particularly the latter, is easily demonstrated by disconnecting the aerial from the receiver after tuning in. There will be practically no background noise of any obtrusive nature if the resistors in the circuit are in good order, and especially if there is an electrostatic shield between the primary and secondary windings of the power transformer. Then when the aerial is connected good speech signals may be rendered unreadable by the background mush which is picked up locally, although this does not represent quite the whole of the noise, leaving genuine static out of the question.

In suburban districts motor-cars and delivery vans within a mile of the receiver contribute a large portion of the scratchy "mush" that is heard. Though the contribution from each is small, yet the effect of dozens of ignition systems produces a very irritating barrage of noise. When a car actually passes along the street in which the receiver is located, a different effect is noted, somewhat akin to the "musical patrol" effect, where the sound gradually rises to full intensity, afterward dying down to join the average mush level. Vacuum cleaners and other electrical machines add their quota to the general noise, making the problem indeed a difficult one, and providing the enthusiastic listener with a broad field for experiment. Although definite systems for reducing interference may be advanced, it is for the listener himself to test the efficacy of more than one, and thus arrive at the best result suited to the particular location and conditions.

It has been established that the lead-in picks up a great deal more of the local interference than the aerial itself, provided that the flat top of the latter is not less than 30 feet high. The problem then is to contrive that the lead-in functions only as a conductor or feeder between aerial and receiver, but that in itself it is incapable of picking up and conveying signals to the receiver. There are two chief methods of accomplishing this—one is to shield the lead-in wire in a metal-covered tube or sleeving of suitable diameter, the metal shielding being earthed.

The second method is to divide the aerial into two equal portions on the "T" principle, the vertical link consisting of a wire from each aerial, the two wires being spaced apart and crossed over at intervals, so that although they conduct the aerial current, each from its respective portion of the top, the repeated transposition of the wires cancels out any signal or noise picked up by the feeder wires. Thus they pass none of the interference to the receiver.

Regarding the first-named system, the listener can do little himself, except purchase the necessary shielded cable which is now obtainable and fix it in place according to instructions. Naturally, earthed shielding of this type extending along the lead-in for many feet is certain to absorb some of the signal energy, though the absence of noise and greater amplification possible is likely to

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fully compensate for such loss. On the other hand, the transposed feeder method produces no loss in the wanted signal strength, and its efficiency may be just as great in suppressing the interference.

The system of employing transposed or neutralised feeders may be extended by having the actual aerial some distance away from the receiver, say on a piece of waste land beyond the back fence, leading the signals to the receiver through a transposed feeder system.

A good system to work upon is the "current-fed doublet" aerial, or half-wave current-fed Hertz aerial with transposed feeders. In this system the total flat top of the aerial is a length equal to half the wavelength to be received, or each half of the top is equal to a quarter wavelength.

As there will be no means of altering the dimensions to suit different wavelengths to be received, a compromise must be settled upon by suiting the dimensions to the available space, compensating the circuit by means of a variable condenser as shown.

Doublet Construction.

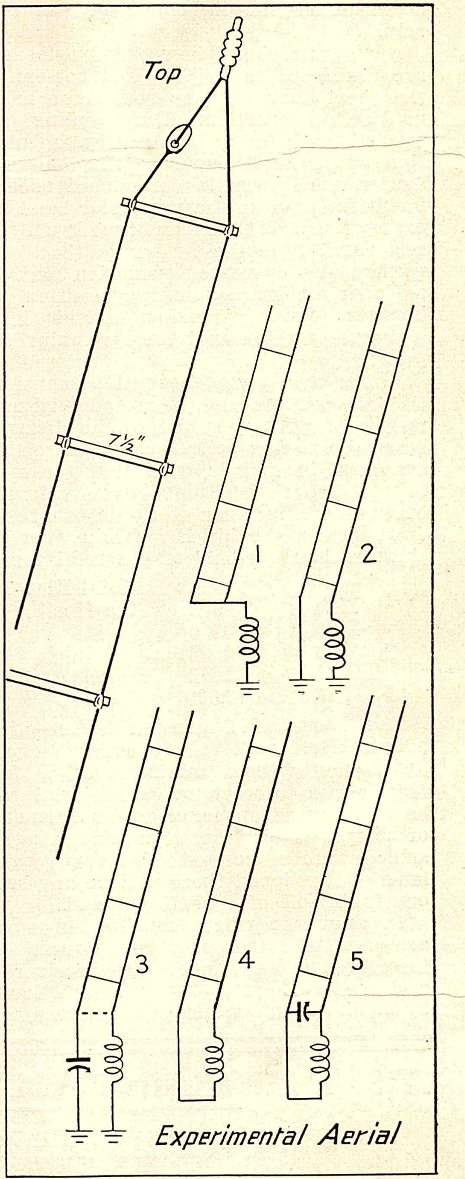
The diagram shows clearly the arrangement of the two sections of the flat top, the best insulators to use being Pyrex. The usual 7/22 gauge enamelled wire should be used for the whole system.

The spacers for the feeders are the only item requiring constructional effort, and will not prove a very formidable job. For ordinary situations the feeders should be transposed every three feet, with the two wires spaced two inches apart. Where the interference is very near or severe, the wires may be only one inch apart and transposed every foot. Find how many spacers will be required, and cut them out of 3-ply, 3½in. x 2¾in. Slot them at the corners with a saw, and remove a good portion of the centre—any shape of hole will do—to cut down dielectric losses. A piece of three-ply 20in. x 7⅛in. will cut into 14 spacers.

The next process is to soak the lot in paraffin wax, so purchase a pound of wax candles, melt in a metal pie-dish on an asbestos mat, with the gas-stove burner turned very low, as precautions have to be taken against the melted wax catching fire. Now immerse in the wax as many of the spacers as can be covered, and hold them under with a metal rod or skewer, taking the bottom one to the top, and keeping them moving until all air-bubbles have come away and no more appear; this may take half an hour.

The spacers are all to be placed at equal intervals along the feeders in order to obtain optimum results.

The actual length of each feeder wire should be equal to half the flat top, or a quarter wavelength, but they may be longer if necessary, which will usually be the case.



The experimental aerial system referred to on the next page.

Ordinary twisted lighting flex has been used by some experimenters in place of the transposed feeder wires as described, and where interference is particularly severe, might be adopted, especially for any indoor portion.

The chief objection to the use of flex out-of-doors is that it is leaky when the covering is soaked with rain, and that even the rubber insulation soon breaks down under the influences of sun and rain.

A diagram shows how the two feeders are connected to the top and bottom of the short-wave primary coil, there being no earth connection. The coupling coil may with advantage be tuned by the addition of a small capacity variable condenser, which remains untouched once it has been tuned to the particular band being received. At the same time it will, on any band, tune the feeder so that the voltage and current distribution may be as near optimum working position as possible, thus increasing signal level while the background level remains the same.

Below are given several dimensions that are suitable, and the one adopted may well be that best suited to the distance between existing poles, or size of section available, bearing in mind that the total flat top length is divided exactly in the centre with an insulator, and that the down leads should, if possible, not be shorter than one-half of the total top.

Metres	k.c.	Total Flat top (feet).
80	3750	125
50	6000	78
31	9670	49
25	12,000	39

The 50-metres dimension is one that adapts itself well to the average available space, with a minimum of 39 feet from aerial to receiver. This aerial will be working at optimum on its harmonic of 25 metres also, but it must not be assumed that in between the two wavelengths mentioned there will be any serious falling-off of collecting-power.

In any case where two lead-in wires are used, the two may be balanced by inserting in each near the receiver a resistance of suitable value, each found by trial. Usual values are between 200 and 400 ohms. With this arrangement it is quite feasible to retain the usual flat top aerial and have the transposed lead-in, attaching one lead-in to the aerial and leaving the top end of the other insulated.

When two lead-ins are used, each must have a separate lightning arrester in order to comply with the regulations.

An Experimental Aerial.

A handy experimental aerial may be constructed of two parallel wires about 60 feet long, separated by spreaders 7½in. long, placed every four feet.

The spreaders are cut from ⅜in. dowel, a 1-16in. hole drilled near each end, and then soaked in paraffin wax as described for the transposed feeders. They are secured to the aerial wires by separating the strands and passing the end of the spreader between, securing with twine passed through the hole in the end of the spreader, and passed around a number of times to hold securely. Brushing duco applied to the twine will prevent rotting.

The two wires are separated at the top end as shown with an insulator, this being the method for best suspension. This aerial is good for either broadcast or short-wave, but may be suspended from one of the aerial poles quite independently of the main aerial. The two wires are led in through tubes or a fanlight, and may be connected in various ways as indicated in the diagram. One wire, or both joined at the receiver, may be used for regular broadcast or short-wave reception, though for the latter one of the alternative methods, discarding the earth connection, may be found to be an improvement (Nos. 4 and 5).

When there is local interference it can often be much reduced by earthing one of the wires, receiving signals on the other with a very small decrease in volume and good improvement in clarity.

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Section 3.

THE LURE OF SHORTWAVE LISTENING

THERE is much to interest enthusiasts who purchase or construct a short-wave receiver. Compared with usual broadcast reception range, enormous distances of thousands of miles are within easy range on short-wave, except upon those occasions when conditions are unkind, or seasonal variations are in evidence on some ranges of frequency.

When static is raging on the broadcast band, and DX is impossible, to change over to, say, 25 metres, and obtain static-free reception from stations at the other side of the world, is one of the thrills experienced by the short-wave fan.

Signals of any frequency used for ordinary transmission travel more easily in darkness than in daylight, though the higher the frequency the less it is affected by daylight. As a rule, it will be found that when reception is good over 8000 or 10,000 miles, there is a considerable band of darkness along the route of signals, although the listener may be in daylight.

It may be stated in a general way that short-wave reception of European stations in New Zealand is better during our summer than during the winter, so that between September and March, there is very fine reception of the Empire short-wave station at Daventry, transmitting chiefly London programmes. The diagram on page 69 shows the position of the directional aerials, or "arrays," as they are called, at Daventry. The chief point of interest is the fact that the array for zone 1 is directed about N.N.E., and not southwards. as might easily be assumed.

The Vagaries of Short Waves.

The direct path to Australia is along the northern coast of Norway, through Tokio, and the centre of New Guinea, while to New Zealand the direct path is almost directly over the North Pole, and the zone 1 transmission is a compromise for the two. We can only be sure of good reception of any Empire transmissions in New Zealand when there is a preponderance of darkness along the route.

During the summer months, while it is dark in New Zealand, the arctic circle is continuously dark, and though it may be daylight in England, the radio waves have only to travel northward a little over 1000 miles to the arctic circle, and over the remainder of the route there is darkness all the way to New Zealand. More favourable still, the route is over water almost the whole distance, which supplies a good reason for the 25-metre transmission being so well received in New Zealand.

Curiously enough, to show that no hard-and-fast rule may be laid down with regard to radio reception, the French station FYA, also on 25 metres, is well received in New Zealand at any hour of the day during our winter months, and weakens off in October, when the Empire station is coming up well. This was the experience of the writer during the past twelve months.

The continuance of daylight to a late hour also reduces strength of reception of the American short-wave transmissions received here late in the afternoon, on 49 metres until about 5.30 p.m. standard time, and on 31 metres, closing down about an hour earlier.

World-wide Entertainment Available.

Given a path of darkness, wonderful reception is available from all parts of the world, and an exploration conducted per medium of the dials will frequently land a prize. An important point, of course, is to listen for a particular station at a time when it is on the air, and the best helps for this purpose are an up-to-date call-book and a world time-chart, the latter to show local time at the transmitter in relation to New Zealand time.

Good speaker reception of the Australian short-wave stations 2ME and 3ME is assured in daylight, with a good receiver, and a ball-by-ball description of cricket test- matches in Australia is one of the treats sometimes put over. Powerful stations are now operating, and may be regularly heard from many foreign countries such as Germany, Denmark, Italy, Japan, Russia, Morocco, Spain, Java, Mexico, France, Holland, and many others in various parts of the British Empire.

Listening In to the "Hams."

A special sphere of interest, apart from that already mentioned, is listening to the amateur transmitters, or "hams," on the 80-metre band, working telephony. A good receiver in New Zealand, besides providing coverage of our own country, may receive Australian amateurs, and on good occasions, Americans on telephony. The "hams" transmit morse to each other on 80 metres, and also on 40 metres, and with special permission, on 20 metres. Thus listeners who care to develop the art of reading this much-used code have a further vast field of entertainment opened up to them. Amateurs on code may be heard from any part of the world, except upon occasions when conditions are adverse.

What You Can Expect.

Beginners will appreciate a statement as to the performance of short-wave receivers, though it must be remembered that care and good components go a long way towards securing the necessary efficiency in a home-constructed receiver. Detector and audio with headphones will give good reception of the more powerful foreign stations all over the world. Detector and two audio with headphones will have the same range as the previous combination, with greater volume. With r.f., detector, and audio valves, the set will have a greater range than with detector and two audio. A four-valve set, employing two r.f., detector, and one audio is ideal, but this means changing three coils for every band, so the more usual scheme is one r.f. and two audio, which makes a very good receiver, giving speaker reception of distant stations when conditions favour. With five valves, two being r.f., world-wide speaker reception is the rule.

Whether the constructor prefers to employ batteries or derive his power from the electric mains, is a matter of choice and location. Screen-grid valves should be used for r.f. and detector, especially as a triode gives very little amplification in short-wave r.f. stages. Though plug-in coils are still widely used, they are bound to lose favour in view of the wave-changing switches that are now appearing on the market.

Freedom from background noise is best obtained by employing r.f. transformer coupling, rather than the "tuned anode" or impedance system, which is more noisy.

The foregoing remarks refer to tuned radio-frequency receivers, but the superheterodyne is steadily growing in favour

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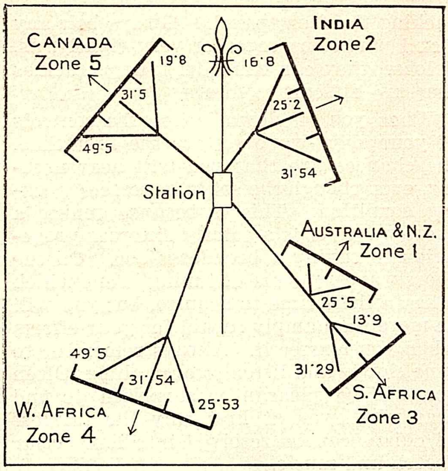

The arrangement of the directional transmitting arrays at Daventry.

for short-wave reception, because of the many improvements recently effected in valves and circuits. A superhet. giving high gain can now be constructed with four valves (excluding rectifier) giving greater selectivity than can be expected from a t.r.f. receiver. With so few valves as four, however, the selectivity is not equal to that obtained with an initial r.f. stage and more than one intermediate frequency stage. Actually, argument is strong in favour of the r.f. stage, especially as coil-switching may now be effected so easily.

Short-wave Constructional Pointers.

Aerials for short-wave work need to be fairly high, well-insulated, with no joints, and not more than 60 or 70 foot overall in length. In fact, a 40 foot aerial often gives best results. As for broadcast reception, the earth should be short, direct, of fairly heavy gauge wire, and soldered to an earth pipe or other metal object buried several feet down in permanently moist earth. Incidentally, it is quite often found that a short-wave receiver works better with the earth lead removed, and for this reason it is always worthwhile when trying out a set to detach the earth lead and compare results before and after.

In short-wave sets all leads should be kept as short and as direct as possible, and above all, connections should be well soldered. A single indifferent joint in a short-wave receiver can utterly ruin its performance. It is the small points that make all the difference between good and bad reception on short waves.

The receiver should, if possible, be built into a metal cabinet, or alternatively on a metal chassis with an aluminium sheet

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backing the front panel. Always bolt any metal partitions together very tightly, as, if loose, they can cause irritating crackles that are difficult to locate.

When you sit down before the controls of your short-wave set for the first time, the chances are that you will hear nothing, even though the set is in perfect working condition. This is because tuning a short-wave set is a totally different proposition to tuning a broadcast one. On the short waves, the art of tuning is one which takes a little time to acquire, but you will be more than amply repaid for your efforts when you master it. Always remember to tune slowly and listen to everything. Often you will be pleasantly surprised to find that what was at first only the faintest of chirps can be resolved into loud, clear speech and music.

Searching on the short-wave bands should be done with the set just "breathing," i.e., just on oscillating, and for this reason smooth control of reaction is most important. In battery sets careful adjustment of the detector plate voltage and a little experimenting with the values of the grid condenser and leak will help greatly toward attaining this.

With these few preliminary remarks we introduce readers to the short-wave constructional section of this year's "Guide." Every set described has been soundly designed and thoroughly tested, and is capable of giving splendid results from short-wave stations all over the world.

Radio Wrinkles

One of the great objections to swinging-coil reaction is the fact that by this method the tuning is not so independent of the reaction setting as when a condenser is used for the latter.

* * *

When a long passage or hall is not available for an indoor aerial and it has to be placed in a very small room, it is generally advisable to try the effect of different positions for the wires.

* * *

In not a few cases peculiar and very unpleasant "zizzes" in loudspeakers of the balanced armature type may be traced to actual vibration of the baffle board. Some of these instruments produce in themselves a great deal of vibration, and these vibrations are transmitted to the board. The result is that whenever a note of the natural frequency of the board occurs, resonant effects are observed. One way of overcoming this difficulty is to make a stand for the unit and its cone and to place it behind the baffle so that the front edge of the chassis just clears it.

LONG DISTANCE LISTENING

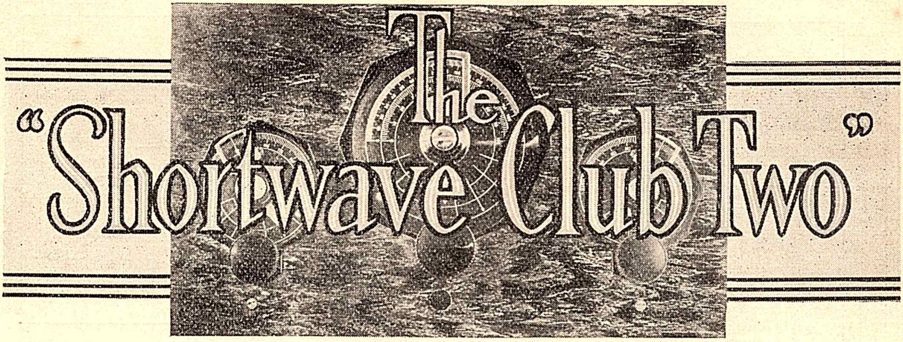
IF you are interested in dxing, or long-distance listening, the NEW ZEALAND DX CLUB is always ready to assist you to identify stations, to help you prepare reports, to supply the latest information regarding schedules and special DX Club broadcasts from overseas stations, in fact, to be of service to you in anything pertaining to DX listening.

The Club has been in existence nearly 4 years, and the membership is rapidly approaching 1200, including over 50 overseas members in England, America, and Australia. The subscription is 2/6, which includes a Membership Certificate and a badge, enamelled in the Club colours. The Club's official organ is the "N.Z. RADIO TIMES," a monthly publication indispensable to everybody interested in radio—whether set builders, dxers, or servicemen—while New Zealand's programme weekly, the "N.Z. RADIO RECORD," devotes several pages each week to DX news.

The N.Z. DX CLUB

Club headquarters are at Box 1680, WELLINGTON, and the Secretary is ready at all times to supply full information regarding the Club to those interested. Branches are established throughout New Zealand.

The "Shortwave Club Two"

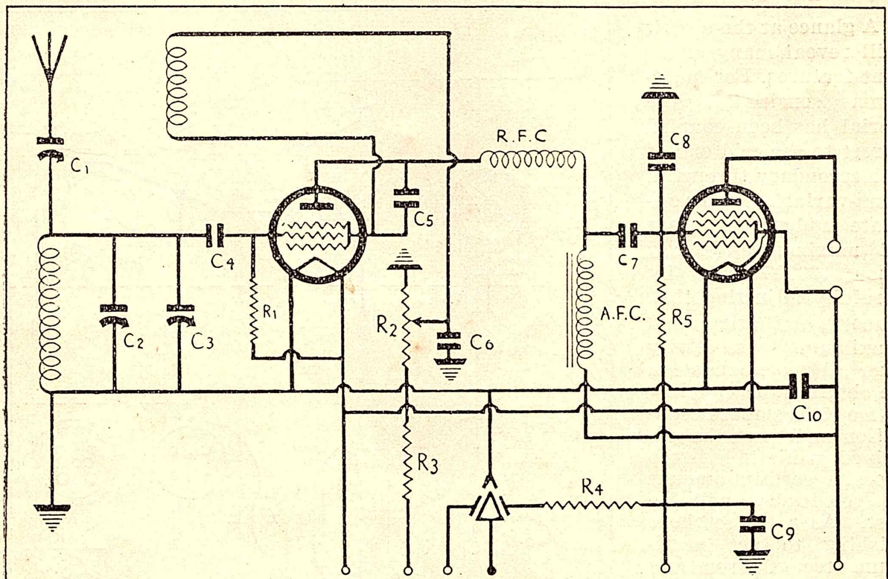


WE make no apologies for commencing the short-wave section with a new description of a receiver described in the "Radio Times" some time ago—the "New Zealand Short-wave Club Two." It is a two-valve battery set employing a screen-grid detector and pentode output.

The history of this little set is interesting. Originally it was specially designed for the Short-wave Club by Mr. Roy Clark, well-known as technical adviser of the Club, and even more widely known as owner and operator of amateur transmitting station ZL2AW.

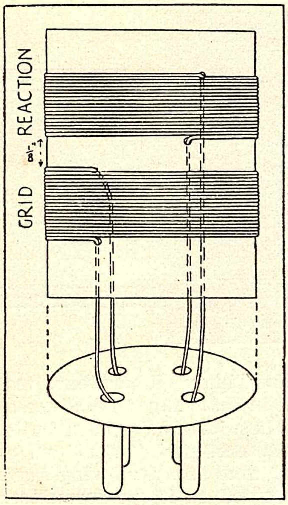
At the invitation of the club secretary, Mr. A. B. McDonagh, the set was built up in the "Radio Times" laboratory, tested and described in that magazine. Since then hundreds of these sets have been built by short-wave listeners and "hams" all over New Zealand, and many glowing reports have been received on its performance.

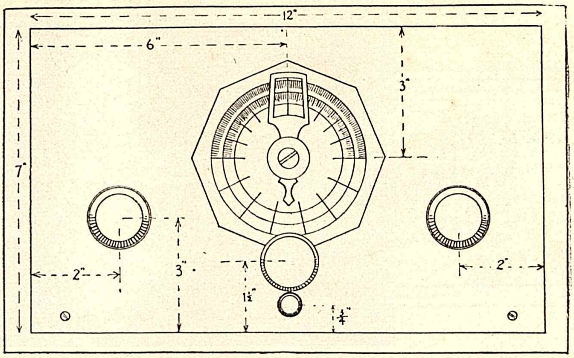
Only the other day a letter came to hand from Mr. H. Stephens, of Katanning, West Australia, who has built up the "Short-wave Club Two" and is very pleased with its performance. He writes: "Daventry has been consistently good on the 31 and 25 metre services, even despite unfavourable local conditions. Occasionally I can put the 25 metre transmission on the speaker."



The Theoretical Diagram.

C1=.00005 mfd. semi-variable (or 3 plate midget); C2=.00015 mfd. double spaced; C3=2 plate midget; C4=.0001 mfd.; C5=.00025 mfd.; C6=.5 mfd.; C7=.006 mfd. (mica); C8=.00025 mfd.; C9=.5 mfd.; C10=.1 mfd.; R1=4 megs; R2=50,000 ohms potentiometer; R3=50,000 ohms; R4=400 ohms R5=1meg.





Left: This sketch shows how to wind on the grid and reaction windings for each coil, and to which pins on the valve socket the connections are taken. Details of the number of turns are given in the panel on the next page. Above: Dimensions for drilling the front panel are contained in this sketch.

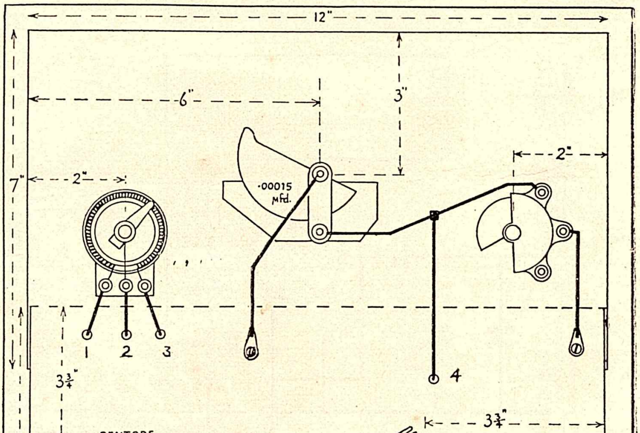
This letter is typical of many others we have received since this set was first described. Unfortunately the issue containing it was sold out long ago, although requests are still coming in for back copies It is for this reason, as well as to enable new readers to build up this outstanding short-waver, that we are now re-describing it.

The Circuit.

A glance at the circuit will reveal many excellent features. For maximum sensitivity, the aerial has been coupled direct to the grid end of the secondary through a semi-variable three-plate midget condenser of maximum capacity about .00005 mfd. By carefully adjusting this, smooth oscillation and maximum sensitivity over all wave-bands can be obtained. If coupling is too tight smooth oscillation will not be obtained, while if it is too loose a certain amount of sensitivity will be lost. As a tip to those wishing to get maximum strength from any station after it has been tuned it, carefully screw this condenser in until reception is loudest. Do not, however, screw it in so far that the set goes out of oscillation.

Another feature is the condenser C3 across the main tuning condenser. This trimmer is a small two-plate midget, which can quite easily be made by taking vanes out of a small midget condenser.

Reaction is controlled by varying the voltage on the screen of the type PM12A detector by means of a potentiometer R2, which should be of the wire-wound type.



This above-chassis diagram should be studied in conjunction with the under-chassis sketch on the opposite page.

This provides a very smooth control, and there is no trace of ploppiness.

Automatic bias is incorporated, the correct bias for the pentode output valve being obtained by means of the voltage dropped through the resistor R4. For a two-volt pentode of the type Mullard PM22A, a resistance of 400 ohms is used, while for a four-volt pentode like the Philips B443, 1000 ohms is suitable.

English valves were used in the original model, although the American types 232 and 233 can be used with equal facility, providing certain minor alterations are made. In the American screen-grid valve, the control grid connection is at the top; in the English valve, this connection is the plate. If a 233 output pentode is used, a five-pin socket will be required. A 1000 ohm bias resistor is suitable for a 233 pentode.

Bringing the Circuit Up-to-date.

It speaks well for the design of this set that only a few minor alterations are needed to bring the set right up to the minute, and even these are unimportant. For example, it is the modern practice to use a battery cable rather than terminals, the various leads being taken through a bush direct to their destinations. Marquis low-loss ribbed coil formers can also be used with advantage.

Coil Details

Metres	Grid	Reaction
10-16	3	4
16-29	6	6
29-52	9	9
50-100	16	14

Winding the Coils.

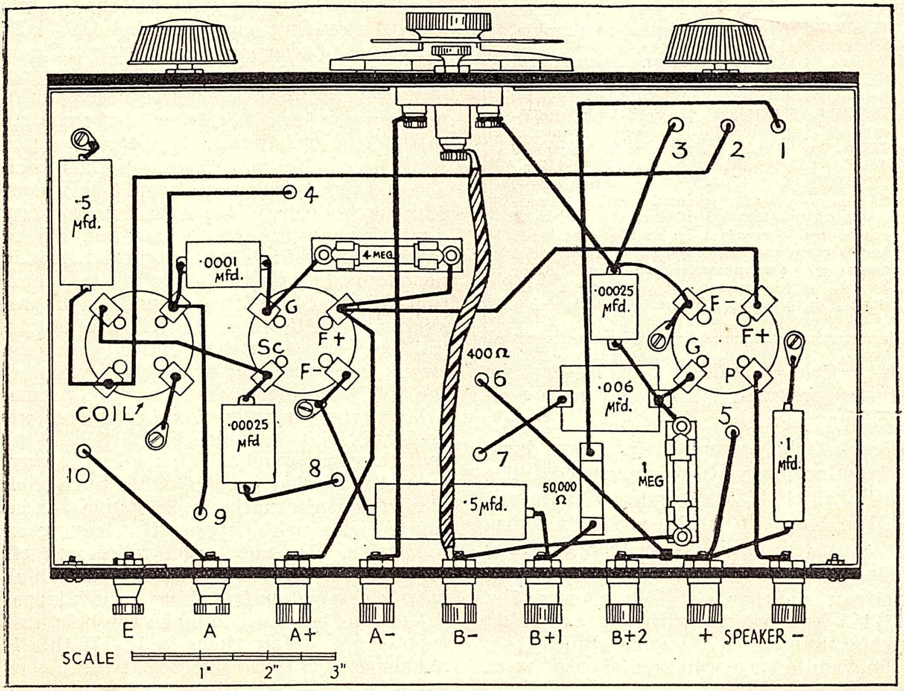
Above are the original specifications for the coils, though as mentioned before, Marquis low-loss formers are preferable to home-made formers.

The coils are all wound with 26 d.s.c. on lengths of former slipped over valve bases and glued or riveted into position. Two-inch lengths of former will be ample for each of the four coils. The method of winding and the connections to the various valve-pins are clearly shown in the sketch on the opposite page.

When all the coils have been wound and the connections carefully checked, clean the legs of all the valve bases, including those of the valves to be used, with emery paper, to ensure good contact.

Building the Set.

The set is a very simple one to build—in fact, the layout and theoretical diagrams give one all the necessary details. How-



Looking at the "Shortwave Club Two" from underneath.

List of Parts.

1 aluminium chassis, 11¾in x 7in. x 1½in., stamped and drilled as shown.
1 ebonite panel, with 24 gauge backing sheet of aluminium, 12in. x 7in.
4 coil formers, 4—pin bases (Marquis).
1 2-plate midget condenser, about .00005 mfd. (Radiokes).
1 .00015 mfd. tuning condenser, double spaced (Radiokes).
1 3-plate semi-variable condenser, .00005 mfd.
1 50,000-ohm potentiometer (Radiokes).
3 UX valve sockets; 2 wafer (Renrade) and 1 reversible (Marquis).
1 r.f. choke, short-wave.
1 audio choke (Radiokes).
1 vernier tuning dial.
2 knobs (Marquis).
1 3pt. on/off switch.
1 pair headphones (S.T.C.).
1 5-wire battery cable.

FIXED CONDENSERS.

1 .0001 mfd. mica (T.C.C., Standard, Solar).
2 .00025 mfd. (T.C.C., Standard, Solar).
1 .006 mfd. (T.C.C., Standard, Solar).
1 .1 mfd. (T.C.C., Standard, Solar).
2 .5 mfd. (T.C.C., Standard, Solar).

RESISTORS.

1 400 ohm wire-wound (Radiokes).
1 50,000 ohm carbon (Ohiohm).
1 1-megohm carbon (Ohiohm).
1 4-megohm carbon (Ohiohm).

VALVES: 1—232, 1—233 (Radiotron, Raytheon, Sylvania, Nat. Union, Tungsol), or 1—A442 and 1—B443 (Philips), or PM12A and PM22A (Mullard).

BATTERIES: 3—45v. "B" batteries (Full-O-Power, Hellesen's, Columbia, Burgess).
1 2 or 4v. 60-amp. hour accumulator (Exide).

MISCELLANEOUS: 2 grid-leak holders (if required); 1 terminal strip, 11¾in. x 1in.; 9 terminals, marked "A," "E," "A—," "A+," "B—," "B+1," "B+2," speaker+, Speaker—. (Strip and last 7 terminals not needed if battery cable is connected directly.) 2 spade terminals for s.g. plate and pentode aux. grid conns.; 1½ doz. assorted nuts and bolts; 1 doz. solder tags; coil push-back wiring; ¼lb. 26-d.s.c. wire.

ever, for those building the set for the first time, we will outline the main constructional points.

When all the components are assembled, construction may be commenced. The chassis, which is of 18 gauge aluminium, is 11¾in. long, 7in. wide, and 1½in. deep. This provides ample room for generous spacing for the components. The front panel can be either of 3/16in. ebonite, 7in. by 12in., and backed with a sheet of 24 gauge aluminium of the same dimensions, or the ebonite sheet can be dispensed with and a sheet of heavy gauge aluminium, say 16 gauge, can be used as a panel.

The first task is to drill the panel to take the three components mounted on it, i.e., the three plate vernier condenser, the tuning condenser, and the 50,000 ohm potentiometer. To do this, the panel and the aluminium backing sheet should be clamped together and the holes drilled right through both at once. The mounting of these three components will keep the backing sheet in place. The shafts of the variable and midget tuning condensers are in contact with the backing sheet, but the potentiometer shaft and that of the on/off switch should be well insulated from it.

The three valve sockets should next be mounted, as shown in the layout diagram. Be careful to orientate the filament pins as shown in the under-chassis diagram. Next mount the aerial condenser, the r.f. choke and the audio choke. Note particularly that the r.f. choke should be of high quality and designed for short-wave work, for a poor choke can quite easily cause a serious loss of sensitivity and stability.

The under-chassis components can now be mounted. The greater portion of the turned down back of the chassis is cut out (see diagram) to take the terminal strip, which extends its full length. There are nine terminals mounted about 1¼in. apart, as shown in the diagram.

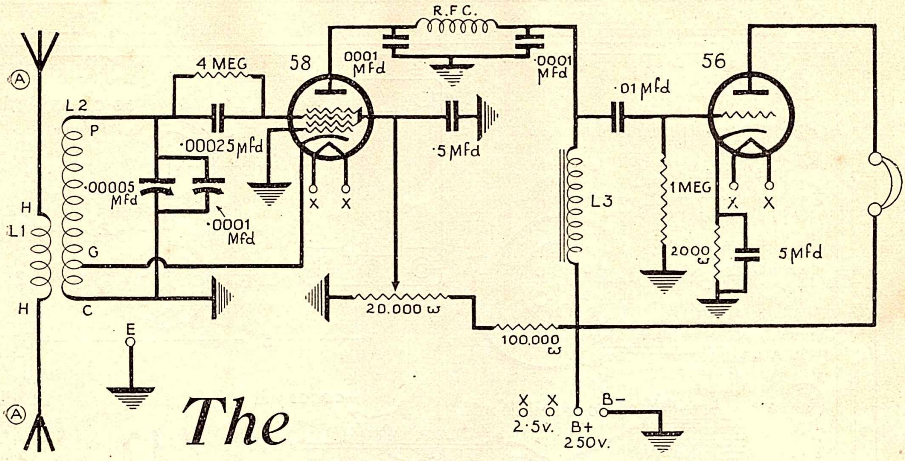
Wiring the Set.

When everything has been mounted, the front panel may be bolted to the chassis and the wiring commenced. All leads through the chassis are numbered correspondingly on the above and under-chassis diagrams. It may be necessary to recess a portion of the front of the chassis to take the on/off switch (see diagram).

A three-point on/off switch has been used, as otherwise there would be a constant current drain from the detector tapping through resistances R2 and R3 to earth. The drain is very slight, but if it is not stopped when the set is not in operation, in the long run it will make an appreciable difference to the life of the "B" battery. It will be noticed from the circuit diagram that with the switch at the "off" position, there is no "B" return.

When the wiring has been completed, all soldered joints should be tested to see that they are sound. Wiring, by the way, is easily carried out by using push-back wiring, or alternatively 18 gauge tinned copper wire with spaghetti sleeving as insulation. Do not forget to smooth off all the holes drilled in the chassis, which may be easily done by taking a much larger drill than that used to make the hole, and revolving it a few times in it. If this is not done, it is quite likely that the jagged edges left will tear the spaghetti sleeving

(*Continued on opposite page.*)



The "VIKING JUNIOR"

DESPITE the many advantages claimed for the superhet for shortwave work, it is significant that most of the "hams" all over the world use receivers very similar to that about to be described. It employs only two valves, a 58 (or 57) and a 56, and yet its performance is such that it has been used regularly to provide loudspeaker reception of the Empire short-wave station's transmissions. However, it was primarily designed for headphone work, though the output could quite simply be fed through an amplifier such as the "1934 Crystal Amplifier" (described elsewhere) to provide full dynamic speaker volume from the main shortwave stations.

An Outstanding Circuit.

Readers of the "N.Z. Radio Times" will notice a close resemblance in the circuit to that of the "Viking Short-waver," described in the November, 1933, issue.

Reaction is obtained by returning the cathode to a tapping on the grid coil, a turn or so from the earth end—a system which gives such fine results that in America it has now been almost universally adopted for sets of this type. Reaction is controlled by a 20,000 ohm wirewound potentiometer, one with a vernier action being preferable. The 58 is impedance-capacity-coupled to a 56, the headphones being connected directly in the plate circuit of this valve.

Coil Specifications.

Band:	Primary:	Secondary:	Tap:
80 metres	5	25½	1¼
40 metres	4	12½	¾
20 metres	3	5½	¾

The Power Supply.

A separate power supply is employed, this being more preferable for short-wave work than building the power-pack into the receiver. The voltage requirements are 2.5 volts a.c. (heater current 2 amps.) and 250 volts "B." These can be taken from almost any broadcast set or can be supplied by a separate power pack such as that to be described at the conclusion of this article.

A four wire cable is required for the voltage supply, which can be taken from various sockets of an a.c. broadcast set by means of another plug to fit the valve socket from which the supply is to be derived. There are several minor considerations which must be watched. The

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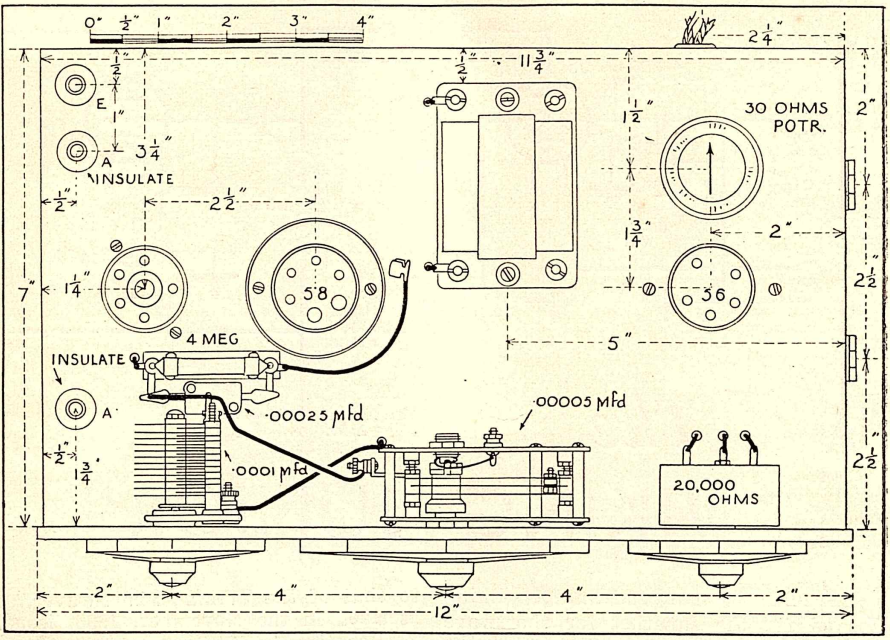
(*Continued from previous page.*)

and cause a short-circuit, with possible serious consequences.

The set is now ready for operation. Connect up the aerial, earth, "A" and "B" batteries, and the loud-speaker, and then switch on. On rotating the reaction control the set should slide into oscillation smoothly. If it does not, reduce the detector voltage and try again. Also slacken off the aerial condenser C1.

When the set is oscillating smoothly, you can commence your search for stations. Keep the set just on oscillation point, rotate the tuning dial very slowly, and listen carefully for carriers. When a carrier is heard, slacken off the reaction just the slightest fraction, and make final adjustments to the trimmer.

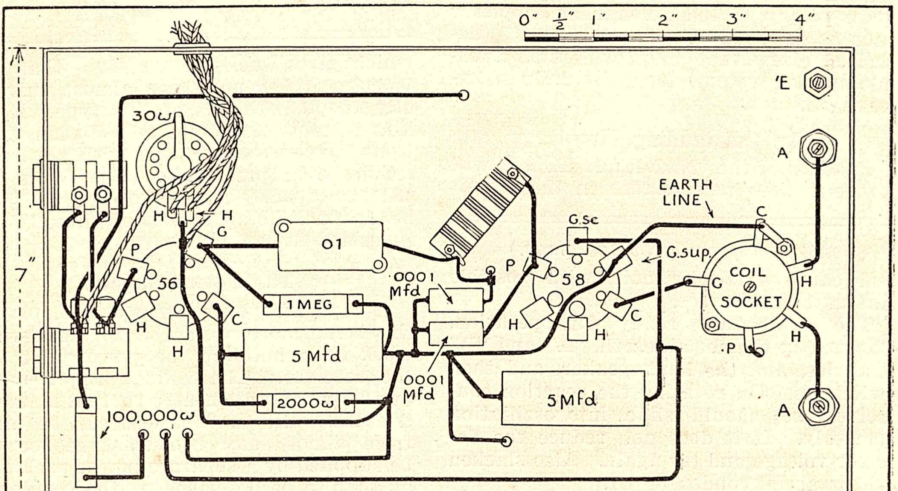


The above-chassis layout of the "Viking Junior."

necessary voltages can be derived either from an r.f. socket or from an i.f. valve from an r.f. or i.f. valve socket.

If the broadcast set employs a 58 and a 56, these two valves should be transferred to their correct sockets in the short-waver, and a supply plug with the appropriate number of pins plugged into either one of the vacant sockets.

The voltage supply cable is wired in the set as shown in the under-chassis diagram. A word of warning is necessary



This under-chassis diagram should be studied in conjunction with that shown above.

here. As the phones are connected directly in the plate circuit of the 56, then if their insulation is defective and the chassis is touched, a nasty shock will probably result. For this reason, the set should either be switched off when the coils are being changed or an on/off switch fitted in the "B+" lead so that the power can be cut off while any adjustments are being made. Still another alternative is to fit an output filter.

Pointers About the Circuit.

It will be noticed that two aerial terminals are shown, so that if desired the receiver can be used with a doublet antenna. However, if the ordinary single wire aerial is to be used, the aerial terminal close to the back of the chassis can be shorted to earth, and the aerial and earth connections then made in the normal way. Because of the inclusion of a bandsetting condenser, tuning will be found very simple. It will also be found that if three vernier dials of good quality are used, tuning will become much easier. A vernier dial is, of course, unncessary on a vernier potentiometer.

One refinement shown in the layout but not in the circuit diagram is a 30 ohm potentiometer connected across the 2.5 volt heater supply. The moving arm is earthed and can be set so that the last vestige of hum is removed. Of course, this addition is not absolutely essential, but will be appreciated by those who prefer their sets to be completely hum-free. Two phone jacks are also shown in the lay-out diagrams, though one can be omitted if desired.

To assist those with "Short-wave Club Two" receivers who might like to try their skill at a.c. construction, this set has been built on the same chassis. Certain minor alterations, which are apparent from the diagrams, have been made.

List of Parts.

1—Chassis, stamped and drilled according to sketch for "N.Z. Shortwave Club Two."
1—Panel and aluminium backing sheet.
1—3 plate variable condenser, .00005 mfd. approx. (Radiokes).
1—.0001 mfd. midget condenser.
3—Vernier dials (1 large and 2 small).
2—Wafer type valve sockets, 1—6 pin, 1—5 pin (Renrade).
1—Coil socket, 5-pin (Marquis).
3—Coil formers, 5-pin (Marquis).
1—High impedance audio choke (Radiokes).
1—20,000 ohm potr., vernier wirewound (Marquis).
1—Short-wave r.f. choke.
1—30 ohm potr., with knob (optional).
1—58 valve shield.
1—Pair headphones (S.T.C.).

CONDENSERS.
2—.0001 mfd. (T.C.C., Standard, Solar).
1—.00025 mfd. mica (" ").
1—.01 mfd. mica (" ").
1—.5 mfd. (" ").
1—5 mfd. dry electrolytic (T.C.C., Standard, Sprague).

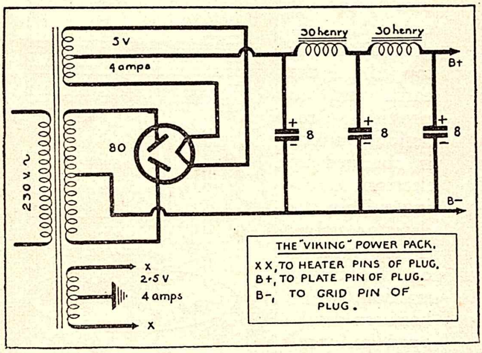
RESISTORS.
1—4 megohm grid leak, with mount.
1—1 megohm resistor (Ohiohm).
1—100,000 resistor (Ohiohm).
1—2000 ohm resistor (Ohiohm).

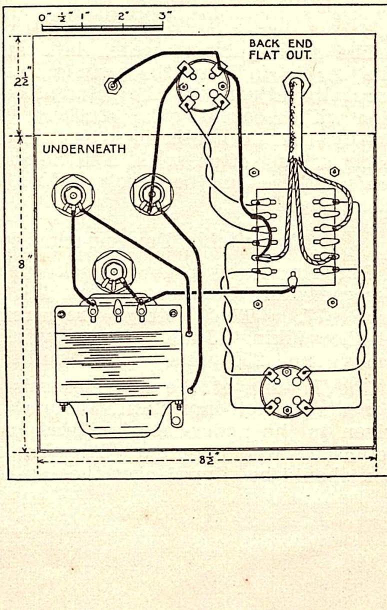
VALVES.
1—58, 1—56, (Raytheon, Radiotron, Nat. Union, Sylvania, Tungsol).

MISCELLANEOUS.
2 phone jacks and 2 plugs; 3 terminals, (2 "A" and 1 "E"); 1—4 wire cable; 2 small bushes (for "A" terminals); 1 large bush (for cable); 1 coil Henley pushback; ½doz. solder tags; 1½doz. assorted nuts and bolts; 1 grid clip. Small quantities 22d.s.c., 32d.s.c, and 18 enam. for winding coils.

Building the Set.

This little receiver is absurdly simple to build. After all the parts, including the chassis, have been obtained, a start can be made by mounting the chassis com-





Above: The circuit of the "Viking Junior" has been specially designed for shortwave work, and the elaborate smoothing ensures a smooth and hum-free "B" supply. Right: The under-chassis wiring of the pack.

ponents. These comprise the aerial and earth terminals, three valve sockets, grid leak clip, 30 ohm potentiometer (if one is used), phone-jacks, power cable bushing and high impedance audio choke. The primary winding of a high quality audio transformer can be used in place of the last-named component.

The chassis should now be laid aside while the panel components, which comprise the band-setting condenser, tuning condenser, 20,000 ohm wire-wound potentiometer, and on/off switch (if one is used) are mounted. As an aluminium backing sheet is used behind the panel, care should be taken to insulate the shaft of the potentiometer. However, this is not necessary in the case of the shafts of the band-setting and tuning condensers, as these should be earthed. It will also be found advisable to earth the moving plates of these condensers separately as well.

The under-chassis wiring may now be commenced, and when this is completed as far as possible the front panel can be bolted into position, and the rest of the wiring completed.

Winding the Coils.

Three coils in all are required. They are wound on Marquis eight-ribbed formers with five-pin bases. The method of winding and the various connections are clearly shown in the accompanying sketch.

All the primaries are wound with 32 d.s.c., the secondaries for the 20 and 40-metre coils with 18 gauge enamelled copper wire, and the 80-metre secondary with 22 d.s.c., close-wound. The secondary windings of the 20 and 40-metre coils should be spaced to occupy approximately one inch, while about ¼in. should be left between the windings on all three coils. The coil details are given in a separate panel.

Operating the Set.

The main point to watch in operating the set is to keep the reaction control carefully adjusted to the point of oscillation while searching for stations. Tune slowly, and do not ignore the faintest of "chirps," as often with a little careful tuning these can be resolved into loud, clear signals.

A Suitable Power-pack.

The circuit of a power-pack specially designed for short-wave work is shown page 77. The voltage requirements of the "Viking" Junior are 2.5 v. a.c. (2 amps), and 250 volts "B" (12 mills.).

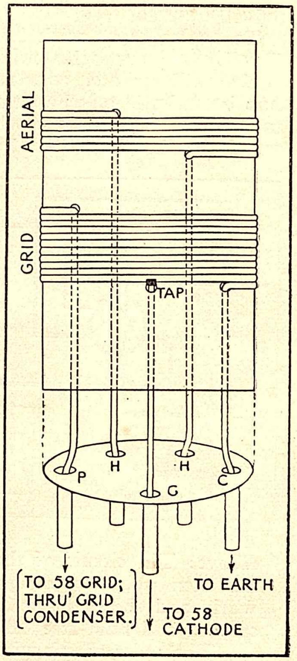
The lay-out of the above-chassis components is not important, though that given in the under-chassis sketch can be followed with advantage. An aluminium box should be slipped over the top of the pack when complete, and earthed by attaching an earth lead to the earth terminal bolted to the rear of the chassis.

List of Parts

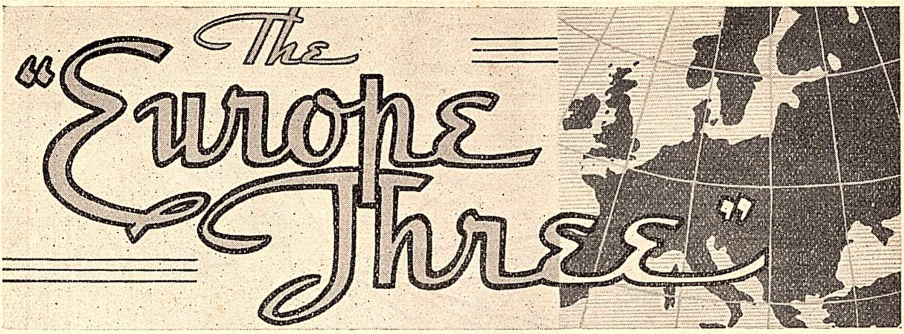
1—Aluminium chassis and cabinet, to dimensions shown in sketch.
1—Power transformer. 385v./385v.; 5v. 2 amps.; 2.5v. 8 amps. (centre-tapped) (Radiokes 1-2).
3—8 mfd. wet electrolytic condensers (T.C.C., Sprague).
2—30 henry smoothing chokes (Radiokes 2-5).
2—4 pin valve sockets (Marquis, Renrade).
1—80 valve (Raytheon, Radiotron, National Union, Tungsol).
1—Length 4 wire cable.
1—4-pin plug (Marquis).
2—Bushes.
1—Terminal marked "E."
1—Length 3-core power flex.
Nuts, bolts, wiring, etc.

This pack will provide a thoroughly filtered "B" supply that in most cases will prove absolutely humless. However, if tunable hum is experienced, it can be eradicated by connecting a .01 mfd. fixed condenser from each plate of the rectifier to the centre-tap (or if there is no centre-tap, to one side) of the 5-volt 80 filament winding.

A complete list of all the necessary parts to build this pack is given in this article.

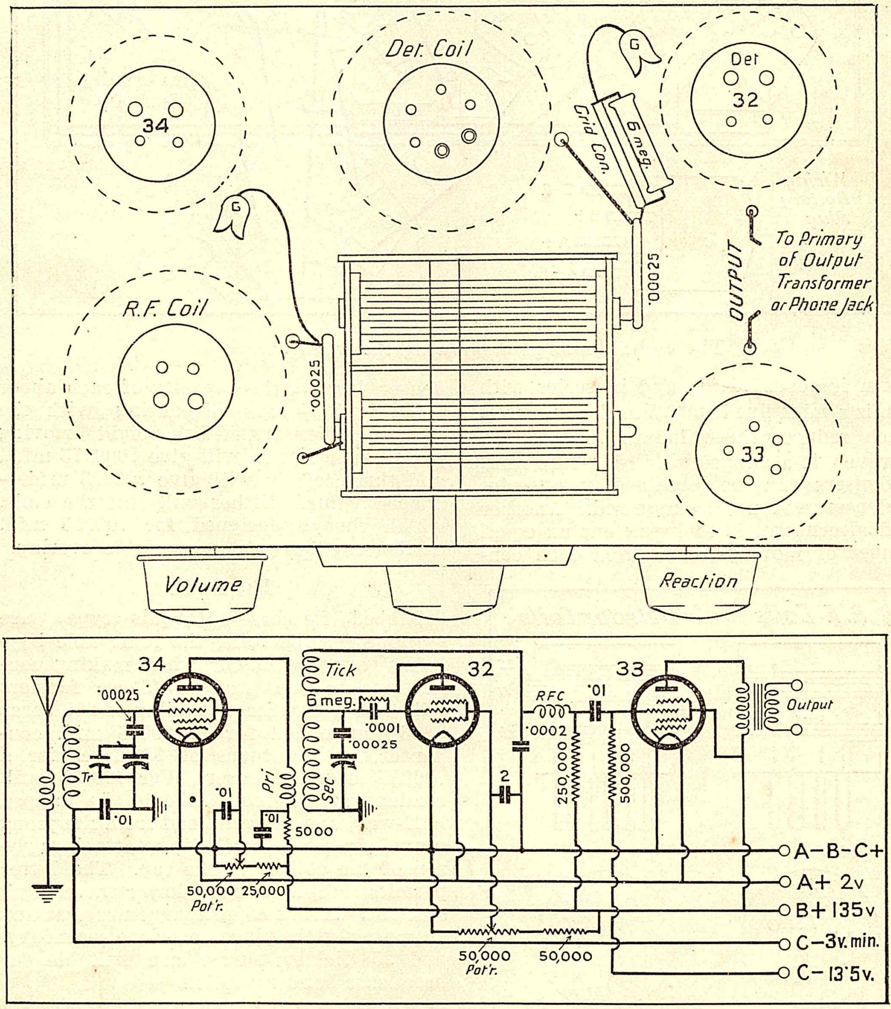


The method of winding the coils is clearly shown in this sketch. Only three coils are required, with two windings on each. The grid winding is tapped near the earth end to provide reaction, which is obtained by electron coupling within the detector valve. This method of obtaining reaction, which has been developed only recently, is very efficient, and enables velvet-smooth control of feed-back to be obtained.

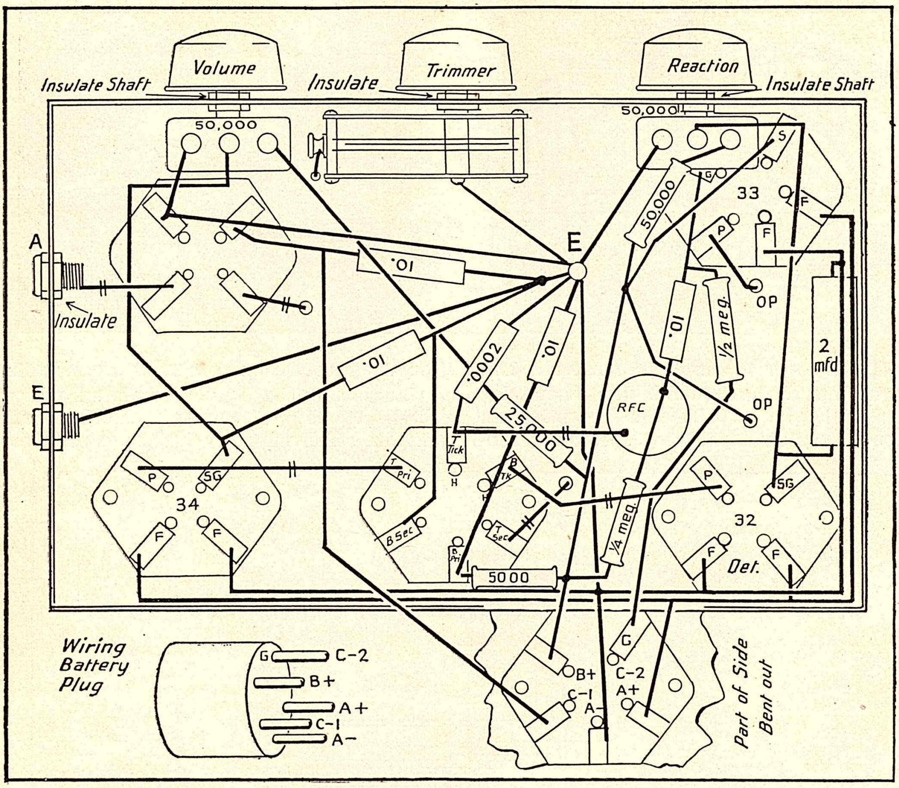


THIS receiver is simple to construct, can be operated economically from dry cells, will give world-wide reception on 'phones, and is capable of speaker reception when conditions are at all favourable.

Ganging of the condensers is simplified by the use of a trimmer across the r.f. portion. The capacity of the condensers

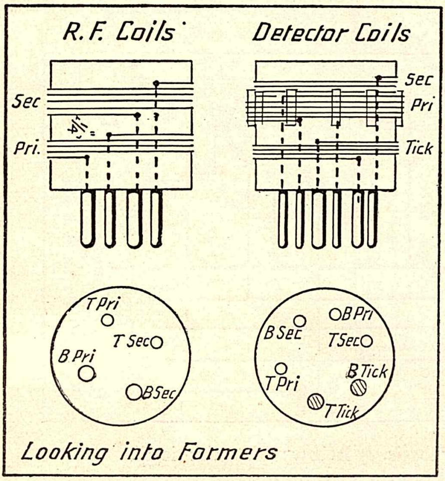


Above: A plan view of the "Europe Three" chassis. Below: The circuit diagram. The tuning condensers are ganged, thus making the set a simple one to operate.



The under-chassis plan, showing the wiring.

shown is .00035 mfd., and in series with each is a mica fixed .00025 mfd. condenser, which reduces the value to .00014 mfd. However, if a ganged pair of .00015 mfd. condensers can be obtained, the series condenser will not be required. Another good alternative is to break out an equal number of moving plates from each condenser, leaving the capacity of each about .00015 mfd., thus dispensing with the series condensers. With eight moving plates, four left in will give .000175 mfd., and three left in will give .00013 mfd.—a good value. Either will suit the coils, which though designed for .00015 mfd. condensers, have an appreciable overlap.



The Coils.

Ribbed formers (Marquis type) are suitable for the coils, the removable base being very convenient when making connections to the prongs. These formers will take a broadcast winding of 200 turns of 34 enamelled for a .00015 mfd. condenser, or 120 turns of 32 d.s.c. for a .00035 mfd. condenser. For .00015 mfd condensers, the coils should be tapped half-way, and the grid lead from the prong provided with a small clip to attach to the top of the coil or to the tap. The latter permits reception of the lower wavelength stations. About 30 primary turns, wound on match-sticks placed over the secondary, and 25 tickler turns, are suitable for broadcast band reception.

All earthing is to one point—which may be one of the holding screws for the condensers—and this point is also connected

Range	R.F.		Detector		
Metres	Pri	Sec	Pri	Sec	Tick
16-30	3	5	3	5	3
27-59	5	11	5	11	5
50-90	8	19	8	19	8

by a copper wire soldered directly to the earth socket mounted on the side of the chassis.

R.f. transformer coupling is used, and is well suited to ganged condensers. A 250,000 ohm plate resistor is shown, but if desired, an audio choke of not less than 300 henrys may be substituted to allow of higher voltage on the detector plate. It must be mentioned that on this type of set the choke feed sometimes gives rise to a howl, but this can be suppressed by placing a high resistance across the choke. However, the 250,000 ohm resistor is safe and sure. Most of the small components are supported by their own wires. The battery wires may be close against the chassis, but the leads (marked with a double stroke) which carry r.f. should be kept well away from the metal chassis.

An output transformer is advisable, but not indispensable. The leads marked "O.P." connect to the primary of an output transformer and the secondary connects to the 'phones, for which a jack, not shown, may be placed in a hole in the side of the chassis. If no output transformer is used, the leads marked "O.P." go direct to the jack. There is room on the chassis for an output transformer, but a more compact method is to fix it under the chassis. If a correctly-matched permanent magnet dynamic speaker is used, no output transformer will be necessary.

A 2½in. can is placed over each coil, and should be easy-fitting.

The Voltage Supply.

The filaments require two volts, from a small accumulator, or two dry cells, with a resistance of 2.6 ohms in series. This may be obtained from a 10-ohm rheostat, with one-quarter of the resistance in. As the cells age, this may be reduced to maintain full voltage. The three valves take a total current of .38 amp.

List of Parts.

1 chassis, stamped as shown, 9½in. x 6in. x 2½in.
2-gang variable condenser, with dial (see text) (Radiokes).
1 3-plate midget trimmer, with knob (Radiokes).
8 ribbed coil formers, 4—4-pin, 4—6-pin, with bases. (Marquis.)
4 wafer-type valve sockets, 2—4-pin, 2 5-pin (Renrade).
2 reversible type valve sockets (for coils), 1—4-pin, 1—6-pin (Marquis).
2 coil shields (see text).
2 valve shields, type 32.
1 short-wave r.f. choke (Lotus).
1 phone jack and plug.
1 pair headphones (S.T.C.) or permanent magnet dynamic speaker (Amplion, Jensen, Magnavox).
1 output transformer, if required (see text).
2 50,000-ohm wire-wound vernier potentiometers, with knobs (Marquis).

RESISTORS.
1 6-megohm carbon (Ohiohm).
1 500,000-ohm carbon (Ohiohm).
1 250,000-ohm carbon (Ohiohm).
1 50,000-ohm carbon (Ohiohm).
1 25,000-ohm carbon (Ohiohm).
1 5000-ohm carbon (Ohiohm).

FIXED CONDENSERS.
1—2-mfd. fixed condenser (T.C.C., Standard, or Solar).
4 .01-mfd. fixed condensers (T.C.C., Standard, or Solar).
2 .00025-mfd. mica fixed condensers (T.C.C., Standard, or Solar).
1 .0002-mfd. mica fixed condenser (T.C.C., Standard, or Solar).
1 .0001-mfd. mica fixed condenser (T.C.C., Standard, or Solar).

VALVES.
1—34; 1—32; 1—33 (Raytheon, Radiotron, Sylvania, Nat. Union, Tungsol).

BATTERIES.
1—2v. 60 amp. hr. accumulator (Exide).
3 45-volt "B" batteries (Full-O-Power, Hellesen's, Columbia, Burgess).
1 18-volt "C" battery (Full-O-Power, Hellesen's, Columbia, Burgess).

MISCELLANEOUS.
Aerial socket (insulated) and 2 plugs; earth socket; 1 coil, Henley push-back; 5-wire battery cable, and 5-pin plug; 2 doz. assorted nuts and bolts; solder tags; 2 grid clips; small quantities of assorted gauges wire for winding coils.

The "B" supply is provided by three 45-volt blocks to give 135 volts, but if the detector plate is fed through a resistance, 150 volts will be better. A 15-volt "C"

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block will provide the necessary 13.5 volts bias for the 33 and —3 volts for the 34. If a Mullard PM22A pentode is substituted for the 33, the bias required will be only —4.5 volts, while the plate and auxiliary grid currents will be appreciably lighter

The .01 mfd. blocking condenser between the filament end of r.f. secondary coil and earth is necessary to avoid shorting the "C" battery.

Winding the S.W. Coils.

Detector primaries are wound over secondaries on eight match sticks glued over the secondary, the bottom turn of the primary to be level with the bottom of the secondary. For these and the ticklers, 36 gauge wire is suitable, and for all other windings, 24 or 26 d.s.c. Ticklers are spaced 1/8in to 3/16in. below secondaries —a slight adjustment may be made by sliding the winding up or down, cementing when o.k.

Connect together "A—," "B—" and "C+" at the battery terminals, taking the common lead to the "A—" pin of the battery cable plug. The other poles of the battery connect to their respective cables attached to the pins of the battery plug.

If either of the tuning condensers proves noisy in operation, insulate the fixing bush from the panel, and connect direct to the earthing-point only.

Section 4.

WITH THE EXPERIMENTER

A COMPLETE AERIAL TUNER

MANY DX enthusiasts have proved to themselves the advantages of tuning the aerial, especially when searching for weak signals. Since the last "Guide" was issued, the tuner has been the subject of much experimenting. Various ideas have been tried out, and the circuit has been reduced to the entail minimum of labour and expense, combined with full efficiency.

The shorter wavelengths on the broadcast band are approaching the fundamental wavelength of the aerial, which may be in the vicinity of 100 metres. Near this wavelength there is no necessity for tuning.

That being so, it was found best to provide a special coil to cover properly the lower half of the band, rather than utilise the lowest reading on the large coil, which does not properly cover the lower part of the band. For this reason a special coil is provided for wavelengths below about 300 metres (1000 k.c.). This coil overlaps the large coil, which tunes down to about 250 metres.

The high wavelength coil (A), however, will be found to increase volume at any setting of the condenser, but particularly on the upper portion.

Short-wave enthusiasts will include the small coil "C," which has been found to suit any band. It consists of 14 turns of 22 d.c.c. on a small former 7/8in. diameter by 1¼in. long. This may be made by rolling up a strip of brown or manilla paper on a ¾in. cylinder.

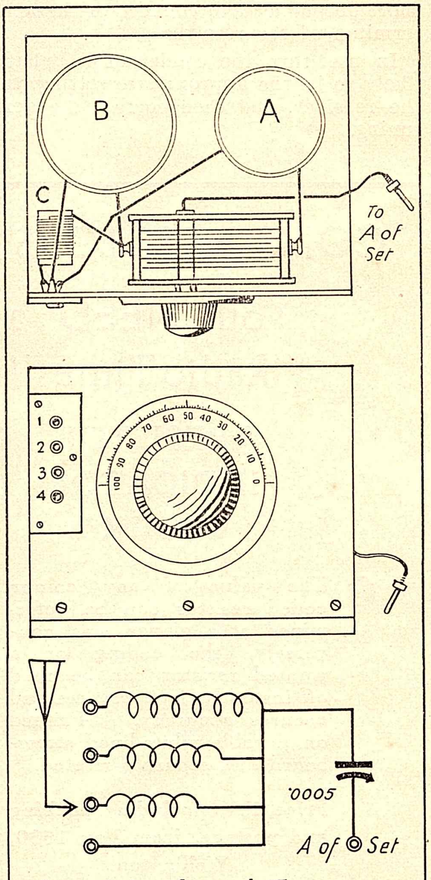
Provision is also made for connecting only the condenser in series for use when occasion suits.

Construction.

A convenient size for the baseboard is 7in. wide by 5½in. deep. A panel of ebonite or 3-ply, the same size, will also be required. Coil "A" is a 2½in., former 4½in. long, wound with 135 turns of 24 d.s.c., giving an inductance of 600 microhenrys. Length of winding, 3½in.

Coil "B" consists of 56 turns of 20 d.c.c. on a 3in. former 3½in. long, the winding length being 2 5-8in. This is as actually constructed with a coil that was on hand, but actual switch-over tests of smaller coils showed that any difference was inappreciable, so long as the gauge of wire was not unduly small.

Alternatives for this coil are 75 turns of 24 d.s.c. with winding length 2in.; 80 turns 26 d.c.c. with winding length 2¼in.,



Complete Aerial Tuner

or 70 turns 26 d.s.c. with winding length 1½in. These are all on a 2in. former. The inductance is 180 microhenrys.

Three sockets, or four to include the short-wave coil, are provided on a strip of ebonite about 3in. x 1¼in. Behind this a rectangular space may be cut in the left-hand edge of the panel to clear the back of the sockets. No. 1 socket connects to the top of the high broadcast coil, and No. 2 to the low, 3 to the short-wave coil, and 4 direct to the fixed plates of condenser. The end of the aerial is fitted with a pin to plug into the required socket.

The .0005 mfd. condenser may be of any make, and a plain dial is all that is necessary.

Glue the coil formers direct to the base, or to a circle of cardboard with a central hole for screwing down.

The top of each coil is connected to its respective socket, and the bottom to the condenser fixed plates. The moving plates terminal of the condenser is fitted with a short output lead to connect to the aerial terminal of the receiver.

In use, turn the condenser to what is likely to be the approximate setting, tune the receiver, and then correct the aerial tuning.

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● The value of any colour coded resistor can be determined at a glance, and conversely, the coding of a wanted resistor can be read off instantly; it saves time and ensures accuracy. Printed on durable white-lined strawboard and securely riveted.

Price 1/-, including packing and postage, from Box 1680, Wellington.

The coils specified are most suitable for use with un-ganged tuning condensers.

THE AUDIO TRANSFORMER

ALTHOUGH resistance capacity coupling is highly suitable to follow a screen-grid detector, the high amplifying properties of the audio transformer still keep it in high favour in amplifiers requiring a second audio stage, or where a triode is used as detector.

Resistance coupling has the disadvantage of limiting plate current on account of the high resistance necessary in the plate circuit, so that it is now becoming more frequent to substitute a high impedance choke for the resistance in circuits where a transformer cannot be used. The only objection to a choke is its expense. Unless the impedance is high, low note amplification will be lost.

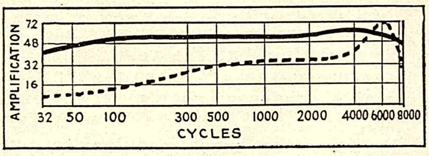
Quality of reproduction may be considerably enhanced by the correct use of the audio transformer, and this article is presented with the idea of showing clearly the several alternative methods available.

Firstly, when purchasing a transformer, it is wise to secure as good an instrument as the purse will allow, because a high-grade make will help considerably toward good reproduction. But whatever the price paid, a suitable circuit arrangement is still necessary. In good amplifiers with a high-grade transformer, it is usual to help quality as much as possible by arranging that the plate current of the previous valve does not pass through the transformer primary, but is "parallel-fed," as will be shown later.

If this system improves the performance of a high-grade instrument, it must actually be of greater benefit to one of less pretentious construction, and which has a core of much smaller dimensions, and upon which therefore a few milliamperes of plate current would have a very detrimental effect. Of course, when the transformer follows a detector taking about .5 m.a., direct feed is permissible.

The better a transformer, the more turns of wire will there be in the primary winding, and this, with increased cross-section of the core, provides the only safeguard against loss of amplification of the deep musical notes. Now a high-grade primary may have an inductance of 200 henrys when parallel-fed, and a low-priced transformer primary might have an inductance of only 34 henrys under the same conditions. With 3 m.a. of plate current flowing through the primaries, the inductance would fall to 80 and 24 henrys respectively, and with these two values of inductance, the reproduction of deep notes would be very different, yet the values given for the cheap transformer do not represent the lowest quality of component obtainable.

It is not only in the inductance of the primary winding that the high-grade instrument scores: "magnetic leakage" and "self-capacity" are two unwanted factors that must be kept down if high notes are to be reproduced without distortion and with good amplification. In the high-grade instrument these two factors are reduced by dividing the primary into an inner and outer section with the secondary in between, and by providing air-space between windings and sections by putting them on specially designed skeleton frames.



Amplification by a good instrument is fairly even throughout the musical scale, but with the low-priced instrument, falls off at the extremes, particularly the bass, as will be seen from the accompanying typical curves. The solid line shows the even amplification of a good component, down as low as 32 cycles, and this is chiefly on account of the high inductance primary. The dotted line shows the weakness of the cheap instrument at the low frequencies. There is very little amplification below 100 cycles, with a rising characteristic to an unwanted "peak" at 6000 cycles, which imparts a high-pitched resonance to the music, emphasising the high notes in an undesirable way, especially when a pentode is employed as the output valve.

Transformer Cores.

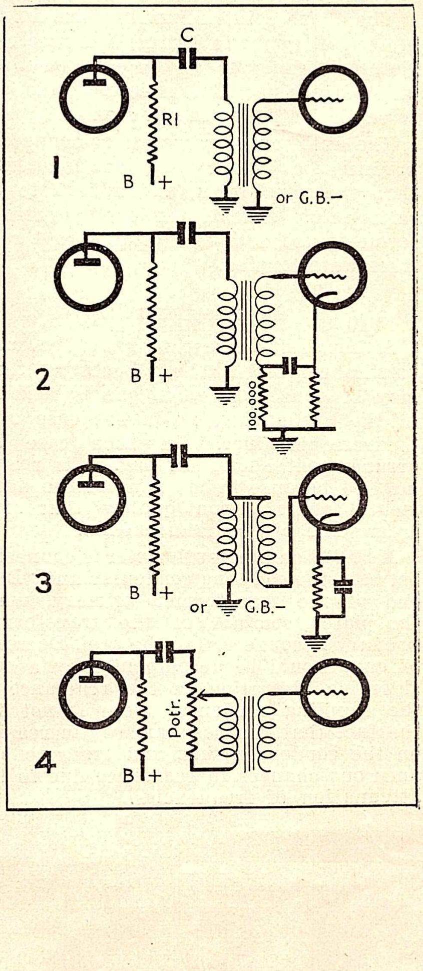
Most transformers have a core built up of stalloy stampings, with a full inch cross-section for high quality. Another core material has been produced by mixing nickel and traces of other metals with the iron, giving a material with much greater magnetic "permeability," thus permitting a greater inductance to be obtained with fewer primary turns and a smaller core than in the usual type. This produces a more compact transformer for equal performance, but on account of the ease with which the core is magnetically "saturated" by direct current, it becomes imperative to parallel-feed this type of transformer in any circuit in which it may be used.

Parallel-feed Circuits.

The principle of allowing only the signal impulses to pass through the transformer primary winding is shown in its simplest form in figure 1, the plate of the first valve receiving its current through the resistance R1, for which a usual value is 30,000 to 40,000 ohms. This value must not be too high, or, in the case of a second audio stage particularly, the plate would be "starved," with consequent detrimental effect upon reproduction. Yet it must not be too low, or amplification will be reduced, and low notes will be weakened.

The coupling condenser "C" plays an important part in connection with the amplification of the lower musical frequencies, and its value must be selected to resonate with the transformer primary just below the lowest frequency which it is desired shall have full amplification; that is, of course, provided that the transformer primary has an impedance sufficiently high to meet the demand. A matching table for coupling condensers will be found under "Parallel-fed Transformers" in the "Facts" Section

In a.c. receivers the equivalent of grid bias is usually obtained by placing a resistor in the cathode, across which is a by-pass condenser, one side of it being connected directly to earth. A better method of connection for any type of inter-valve coupling, except auto-transformer, is as Fig. 2, where it will be seen that the condenser, for which 1 mfd. is ample



capacity, is now connected to the transformer secondary, and to earth through a resistance of not less than 100,000 ohms. By this means correct de-coupling is provided, so there can be no loss of quality.

Auto-Coupling.

While still retaining the parallel-feed features, the two windings of a transformer may be connected together in such a way that more than the nominal step-up ratio is produced. This method is known as "auto-coupling," and consists of connecting one end of the secondary to one end of the primary winding, and the other end to the grid of the next valve (Fig. 3).

In this way both the primary and secondary voltages are applied to the grid, and the primary voltage represents the increase in amplification or step-up over the normal method of connection. There is one precaution that must be observed in connection with the cathode by-pass condenser, which must be connected as shown in the diagram. This should have a capacity of 25-50 mfd., which can be conveniently provided by an electrolytic low-voltage type.

The above points regarding bias do not, of course, apply to battery-fed receivers. Note that the primary is connected to the bias battery negative in battery sets, and to earth (cathode) in a.c. sets.

The auto-coupling system of connection produces a flatter amplification curve than the usual plan, and adds 1 to the ratio value, that is, an ordinary transformer rated at 3 to 1 gives 4 to 1 ratio when auto-coupled.

Volume Control.

Although it is best to have the main volume control in the r.f. stages, there may be conditions when one is required in the audio side, as in the case of a separate amplifier. In such case the arrangement shown in Fig. 4 is recommended because it has none of the detrimental effects upon quality that arise from some other arrangements.

A 50,000 ohm potentiometer is connected between the coupling condenser and "B+" end of the transformer primary, while the plate terminal of the transformer primary is connected to the arm. Decrease of gain would be accompanied by a considerable alteration in the reactance of the coupling condenser were it not for the fact that the resistance is increasing on the condenser side, and tends to balance out changes in reactance due to the attenuation of frequencies.

TUNING COIL CONSTRUCTION

EVERY experimenter finds himself some time or other in need of special coils which have to be constructed to suit the task in hand. Probably he has some former tubing, but the vexed question is "how many turns?" to suit a particular variable condenser that may also be on hand.

Perhaps the most popular condenser capacity is .0005 mfd., because it covers the required range with more compact coils than do the smaller capacities. In spite of this, the .00035 mfd. is quite a useful condenser to have on hand, and does not mean a great many more turns on the coil.

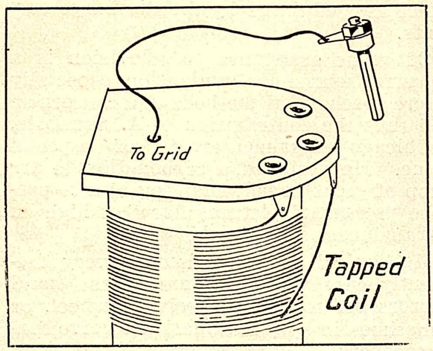
The inductance of a coil is measured in "microhenrys," and for a given condenser capacity to cover the full broadcast band from 200 metres (1500 kilocycles) up to 556 metres (540 kilocycles) the coil must have a certain inductance, otherwise the band will not be covered. For a .0005 mfd. condenser the inductance must be 175 microhenrys and for a .00035 mfd. condenser, 250 microhenrys.

Having given this preliminary explanation, it is now possible to explain clearly the use of the "Solenoid Construction Chart" at the end of the book. Once the use of this is learnt, coil problems can be quickly solved.

Using the Chart.

Suppose we have on hand a .00035 mfd. condenser and a 2-inch former, and wish to construct a coil to cover the broadcast band. Start at column G. Place a ruler on .00035 mfd., across to 250 microhenrys in column E, which shows in column F that it will tune to 560 metres. Or, if we wish to tune to 600 metres maximum, the inductance of the coil is shown to be 300 microhenrys. Now to proceed with the 250 mch. coil. Hold a pin at 250 and bring the ruler round to join it to "2 inches" in column A, the diameter of the former. Now place the pin against the ruler where it crosses the "base line."

Now we are in a position to choose any gauge of wire to be purchased, or that may be on hand. Swinging round to 26 d.c.c. 100 turns is indicated, having a winding length of 2¾ inches. But there may be some 30 gauge double silk-covered on hand, so swing the ruler round on the pin to 30 d.s.c. and we see that 73 turns will serve, having a winding length of 1⅛ inch. The turns and winding length for any wire may be found by simply swinging the ruler round against the pin. When the required inductance is known, start at column E, say 175 mch., to 1½ inch former; now the pin will be in a different position on the base line, and we find that



70 turns of 32 gauge enamelled will give us the required coil.

Now suppose we wish to find the inductance of an existing coil which has 80 turns of 24 d.s.c. with a winding length of 2⅛in. on a 2in. former. Place the ruler across 24 d.s.c. in column B and 80 in column C. Now place the pin against the ruler on the base line, swing round to 2in. former, which leads to 200 microhenrys. By placing a pin there, we can see what is the maximum wavelength with a given condenser.

The minimum wavelength with either condenser mentioned will be just under 200 metres (1500 k.c.) provided that there is not excessive unwanted capacity in the circuit, and that the coils used are a reasonable shape—not too long in proportion to the diameter. Try to keep the winding length not more than one and a half times the diameter of the coil, because the nearer the winding length and diameter are to being equal, the better is the coil proportion. Badly proportioned coils are produced by using too heavy a gauge of wire on a small diameter of former. Use no heavier than 24 gauge on a 2-inch; or 30 gauge on a 1½-inch former; much thinner gauges will give good results.

A Compact Broadcast Coil.

A really compact, yet efficient broadcast coil can be wound on a paper tube 3in. long, 13-16in. diameter, and wound to a a length of 2¾ inches with 40 d.s.c. wire. The tickler is wound at the earth end of a paper tube the same length and 9-16in. diameter, placed inside the main coil. The primary is wound on a strip of paper over the earth end of secondary. The whole is shielded in an aluminium shaving-soap container, and makes a neat component suitable for a portable or other receiver. Using a .00015 mfd. condenser, this coil does not cover the band below 230 metres (1250 k.c.), but with a .00035 mfd. would cover it completely.

Double-silk insulation makes the best coil, because of the slight spacing afforded, and the fact that silk is a good dielectric. The word "best" is used in the sense that a little more amplification is provided by such a coil compared with enamelled insulation.

Another use for the chart is that of finding the minimum tuning for any particular coil and condenser. In this case we are up against a somewhat variable factor—the capacity of the circuit itself, apart from the minimum capacity of the condenser. In a low-loss short-wave circuit that is carefully designed and constructed, the total minimum capacity of condenser and circuit may be as low as .000005 mfd., but in some receivers may be as high as .00004 mfd.

We can take .00003 mfd. as a working basis, and mark this on line G of the chart as the minimum for any circuit. By placing a ruler from this point to the known inductance of the coil in microhenrys, the lowest tuning point is shown on line F, but if the capacity of the circuit is high, the tuning will not be quite so low as indicated.

All-Wave Broadcast Coils.

Owners of short-wave receivers often wish to construct broadcast coils to plug in, and are confronted with the difficulty of tuning-in broadcast band stations with the small capacity condensers usually found in a short-wave set, sometimes of .00005 mfd. capacity.

In these circumstances the procedure is to construct a 1½in. coil by slipping a former over a valve base, and to provide for tapping the coil near the centre, or in two places for a .00005 mfd. condenser, securing to the top of the coil a small piece of ebonite containing one socket connected to the top of the coil and one or two others connected to the taps. A flexible wire comes up from the grid pin connection, terminating in a split-pin which may be inserted in one of the sockets. Connection to the top of the coil gives the high wavelengths, and to a tap, the lower portion of the broadcast band.

Reference to the chart shows that to reach 550 metres (445 k.c.) with a .00005 mfd. condenser, a coil of 1750 mch. is necessary, and that this will tune down to about 440 metres (680 k.c.); to tune to 450 metres (655 k.c.) an inductance of 1200 mch. is required, with a minimum of 350 metres (875 k.c.); to tune to 360 metres an inductance of 760 mch. is required, and so on. Finding the number of turns to give these inductances, taps are required at 250, 170, 110 and with the top, 300, 4 sockets are required.

Only 36 gauge enamelled wire is suitable for this coil, the winding length being 2½ inches. Over this, space must be allowed for a tickler, unless placed inside the coil. This is an extreme case, but shows how the difficulty may be overcome—it is much easier to change taps than to change coils. With the more usual .00015 mfd. condenser, 32 d.s.c. wire is recommended for a coil of 570 mch., tuning from 550 down to 230 metres, and, with a tap at 80 turns, from 300 down to about 130 metres. Total turns, 180 on 1½in. former, winding length 2½in.

A BRIEF REVIEW OF TELEVISION

RADIO enthusiasts are awaiting the time when television will become a part of their radio activities, but at the present time the best counsel is "wait and see," because new developments appear to be very near at hand.

Transition from the mechanical method of scanning, which employs a revolving scanning-disc, to the electrical method. employing a cathode ray tube or similar device, is almost certain to come, as it appears extremely likely that greater perfection will ultimately be attained by the latter method. At present the size of picture received is more limited by the cathode ray tube method than by the scanning-disc, but it appears reasonable to suppose that this difficulty will be shortly overcome.

One of the most promising announcements during the past year was the arrival of the "iconoscope" or artificial eye, produced by Dr. Zworykin and his staff after ten years' research. Briefly, it is a vacuum tube with a photo-sensitive surface scanned by a cathode-ray beam which serves as an inertia-less commutator, permitting high output with a sensitivity equalling that of a moving-picture film.

In the tube is a 4 x 5in. mica sheet containing three million cells which are the main feature of the device, and which turn the light impulses into electrical energy. which is received in the usual way and translated into light impulses by the cathode-ray tube of the kinescope, also developed by the same inventor. The fact that the eye cells "store" the light impulses for an appreciable fraction of time gives an output many thousands of times greater than that obtained by the brief duration of a "scan," and thus amplification becomes a simpler problem.

An ordinary cinema lens concentrates the picture upon the iconoscope. Transmitted detail is at present equivalent to 250 lines per inch. In the narrow part of the tube a cathode ray gun throws a stream of electrons toward the plate of cells, and as the back of the plate is made conductive by a coating of metal, each cell acts as a small condenser, the charges varying with the brightness of the image thrown upon them by the lens. The electron stream is deflected from side to side by exterior deflecting coils, and its varying discharge effect upon the cells is received upon a fluorescent screen across which a cathode beam is also moving and which is modulated by the discharge currents.

Of great assistance to television is a powerful source of illumination, especially where mechanical methods are concerned. and thus the contribution of A. Sanabria, a Chicago experimenter, is of especial value. He designed a carbon-dioxide arc lamp of great power, enabling him to produce "scanned" pictures five feet high on a translucent screen.

Mechanical scanning is now very frequently carried out by numerous small mirrors set round a revolving wheel, or sometimes in spiral formation to give surface coverage. The inventor of the latter device, a Hungarian, has also discovered that a zinc sulphide crystal used in a television receiver is capable of much higher modulation efficiency than any previously used, and thus allows of a much larger image being projected from the scanning mechanism.

In Germany the "intermediate film" process has been improved, so that the scene to be televised is photographed on a continuous band of film which is exposed, developed, and in less than ten seconds after exposure, still wet, passes the scanning disc. After this the picture is removed, the film resensitised and dried, ready to pass once more through the camera. The same apparatus may be used to receive television from a distance, first registering the picture on the film, after which it passes through a special projector which shows the film as a positive, enlarging on the screen to 12 x 9 feet.

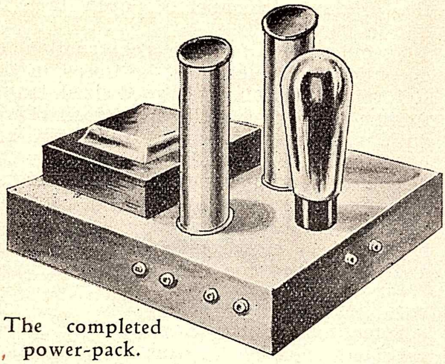
In England the B.B.C. has been transmitting television experimentally for some time under a contract with the Baird Company, which expires this year. However, as the B.B.C. is highly interested in television development, no doubt a further contract of some kind will be made.

The German post-office transmits a regular experimental television service of scanned pictures on ultra-short waves.

It is possible that 50 cycles may be adopted as a standard synchronising frequency, so that where the electric mains are all frequency-controlled, as in the English "grid" system, the problem of synchronism will be simplified.

A SIMPLE POWER-SUPPLY UNIT

THIS is a handy power-supply unit that will serve the experimenter for any ordinary type of a.c. receiver up to six or seven valves if the transformer is equipped with the necessary a.c. filament windings. It is assumed that a small dynamic speaker is to be used, having a field winding of 2500 ohms resistance, which is connected up to serve as the smoothing-choke.



The completed power-pack.

As there will be a drop of about 100 volts in the speaker, the transformer should be capable of delivering not less than 360 volts from each side of the high voltage winding. The transformer shown is the small above-chassis mounting type, but any make of transformer may be used.

A transformer with an electrostatic shield between primary and secondaries should be procured if possible, especially if short-wave reception is contemplated, because this arrangement prevents noise entering via the power-lines.

Two electrolytic condensers of 8 mfd. capacity are required, and care must be taken that the positive or red pole of each is connected as shown to the "B+" side. Some of these condensers require insulating from the chassis with a strip of ebonite, but this depends upon the make. Usually the condenser can be screwed directly to the chassis, as the centre terminal is the positive pole.

A separate 5-volt winding is used for the 80 filament. One side of this winding is connected to one of the speaker field banana sockets and to + of one of the condensers. The two thin prongs of the 80 are connected to the high voltage secondary leads from the transformer, and the h.v. centre-tap is connected to the chassis.

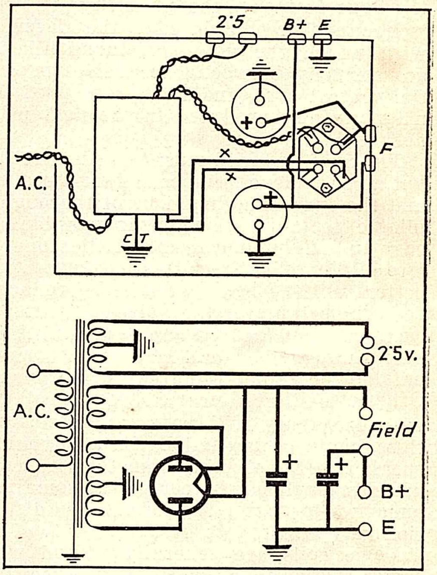
For a small receiver of, say, three valves, the power-supply would answer quite well as shown, but when more filament windings are necessary, extra pairs of sockets must be provided. As shown, it would be quite feasible to arrange the 2.5 volts and "B+" and "B—" to plug in with a four-pin socket and valve-base. The socket marked "E" is connected to the chassis, and should be connected to the receiver earth.

List of Parts

Aluminium chassis, 8in. x 6in. x 2in.
Power transformer, 2.5v. 4 amp., 5v. 2 amp., 385v./385v. high voltage secondary (Radiokes).
2—8 mfd. wet electrolytic condensers (T.C.C., Standard).
1—4-pin wafer socket.
1—80 valve (Radiotron, Raytheon, Nat. Union, Sylvania).
6—Banana plugs and sockets.
Length 3-core power flex, and plug.
Coil Henley push-back wiring.
1—Bush (for power cable).

Building the Pack.

A chassis 8in. x 6in. x 2in. will be ample size—the transformer is the chief item causing variation. If a speaker field is not used for smoothing, two No. 5 or No. 9 chokes (see Reference Section) will be required, with a 2 mfd. paper condenser connected with one side between the two and the other side to earth. In this case the voltage drop would be about 20 volts in each, or 40 altogether, so the transformer voltage could be around 300 volts.



It should be noted that there must be some consideration of the current-capacity of the speaker field, which is probably rated to carry up to 60 m.a. with some temperature rise. Greater current will cause the winding to become hot, and the best remedy for this is a field of lower resistance, say, 1000 or 1200 ohms, which would probably carry up to 100 m.a. without undue heating. (One pound of 36 gauge enamelled wire has a resistance of 1000 ohms).

For short-wave reception a short-wave choke placed in each high-voltage lead at "XX," between transformer and rectifier, will reduce the hum resonance that is sometimes rather pronounced on the higher frequencies. This choke should not be too large, and 80 or 100 turns of 30 gauge enamelled wire on $\frac{5}{8}$in. or $\frac{1}{2}$in. former respectively is ample.

S W choke.

THE DYNAMIC SPEAKER

A LOUD-SPEAKER which is rapidly becoming popular is the dynamic type, with a cone about 5 inches in diameter, and with a field winding of fine wire of a resistance of either 1250 or 2500 ohms, suited to act as the only smoothing-choke for the "B" supply.

This type of speaker has a field magnet made of stampings and a solid central core about 1 inch in diameter, and actually the reduction of iron in the magnet has made for greater efficiency in comparison with the heavy "pot" casting in the larger types.

Quality Considerations.

Important items affecting quality of reproduction are the material of which the cone is made, the pliability of the "surround" or holding edge, the closeness with which the voice-coil turns fill the annular gap between the face-plate and the central core, and the strength of the magnetic flux produced in the field magnet.

The cone material must be as non-resonant as possible, of rubber or fabric nature, and the surround should be of thoroughly pliable leather, allowing, if possible an easy in-and-out movement of the cone of ⅛ to 3-16in. The freer this movement, the better will the bass notes be reproduced. It is important for the voice-coil turns to occupy as much of the gap as possible, and also that they should not project much outside the gap at the greatest movement. Otherwise the alteration of impedance with frequency will be accentuated, and this should be negligible in a dynamic speaker. If not, the transformer ratio matching will not be correct at some frequencies—probably the lower—and distortion may result.

Voice coils are generally wound with either two or four layers of wire, so that the two wires come out at the same end of the coil. To save space the turns on a succeeding layer rest in the grooves between turns of the previous layer. Looseness of end turns is a possible source of rattle, and the cure is a coat of thin celluloid cement—do not use shellac.

Any tendency to looseness of overlapping joints in the cone material will produce rattle, and a careful inspection should be made and rubber solution used to stick the parts together.

In the general run of speakers, the output transformer to suit a given output valve, or pair, is incorporated in the speaker, but the experimenter may sometimes require to change from a single valve to push-pull, or to a larger single valve. Thus, if no ratio tappings are provided on the transformer—and as a rule they are not—another transformer must be used, and the original disconnected, even if it is left in position.

Specifications for the construction of output transformers will be found in the Reference Section. A good-sized transformer of correct ratio gives good reproduction. The secondary wire should not be of too fine a gauge, because actually the secondary winding should have a lower d.c. resistance than that of the voice-coil. In practice this cannot always be the case, but the best compromise can be arrived at by not using too thin a gauge of wire.

Re-Winding Fields.

Sometimes it may happen that an experimenter wishes to re-wind a speaker field to carry greater current than the present winding will stand without undue heating.

Many small speakers have a field winding of 38 s.w.g. enamelled wire (34 B. and S.), and the one pound usually contained on the spool has a d.c. resistance of about 2500 ohms. When a receiver taking 40 m.a. or more has such a field connected as a smoothing-choke, considerable heat is generated in the coil, and there is a drop of 100 volts in the "B" supply. Certainly the magnetic field produced will be a strong one, and all the better for that, but suppose the output is changed to push-pull from a single valve, there will then be probably another 30 m.a. to be carried, and either a new speaker or re-winding will be necessary.

To carry 70 m.a. the new winding would be of 34 s.w.g. wire, the fewer turns being compensated for by the extra current passing. About one pound of wire is necessary, jumble wound, with an occasional close-up layer of paper, putting on sufficient wire to fill the spool.

As the gauge of wire increases, more space is lost by the crossing of turns when jumble winding. Layer-winding is laborious for so many turns, and scarcely necessary, but if attempted, the paper used between layers should be little thicker than tissue. Otherwise too much space will be lost. The average winding space in these fields is 1½in. x ⅝in.

The large-sized pot magnet has a space of about 4in. x 1in., and one of these originally wound for 6 volts may easily be converted to use as a choke by layer-winding 30 gauge enamelled wire to carry from 80 to 130 m.a. Full layer winding is not necessary, so the best method is to jumble wind about 1000 turns, then put on a paper, and continue with the next layer. There will be about 16,000 turns, and a d.c. resistance of about 900 ohms, so that the drop for 80 m.a. would be 72 volts, or for 100 m.a., 90 volts. About 6lb. of wire is required.

Any speaker winding may be successfully changed as outlined by looking up the wire table in the Reference Section and finding the gauge that will just carry the current, or even with a slight overload in the case of a small speaker. In the large sizes more margin can be given because the dimensions are worked out on a more liberal plan. All that is necessary is to get as many turns as possible in the available space, which means keeping the spool dimensions as large as possible.

When the moving-coil develops a buzz due to the coil touching the side of the gap, loosen the screw in the centre of the "spider," and insert between coil and gap at equal intervals, three ¼in. wide strips of thick paper or thin card, according to the space available. When these are equally placed, tighten the screw holding the spider, and the coil will be accurately centred.

Quality of Reproduction.

Good quality is obtained from any reputable make of speaker. From 5in. cones or larger, the reproduction of bass with a suitable baffle is good, increasing in volume somewhat in the 8in. and 10in. sizes. Those with the cone less than 5 inches in diameter are not intended to reproduce much below 100 cycles, and are therefore slightly lacking in bass response, though still giving pleasing results. Quality cannot be expected from any speaker unless it is fed with the output of a good amplifier, and has a fully excited field-magnet.

The judging of quality reproduction only comes from experience, resulting in a thorough knowledge of what can be expected. One learns how to pick out the good and bad points, and generally to judge quality and place it in its proper category.

Good tone is round and smooth, without any tendency to "scratchiness." If this is present, the receiver must be looked over—grid-leak detectors are often offenders, or it may be too low plate voltage on one or more valves; low voltage on the heaters; poor audio transformer (if one is used); valve "going off"; incipient audio oscillation caused by feed-back, etc. Placing a compo. resistor of 20,000 ohms or more in the output grid lead and a 100 ohms wire-wound resistor in the output valve plate lead will often effect improvement of tone, and can do no harm.

If heaters are "down" it is possible, if there is a slight space in the power transformer "window," to put on the necessary extra turn or two outside the winding, but it must be well insulated wire, and its direction must continue that of the winding already on.

As the amount of plate current consumed by the average receiver grows, speaker fields of 1250 ohms or less will become increasingly popular, because 60 m.a. through 2500 ohms drops 150 volts, which means high initial voltage and higher test smoothing condensers, while with this current the field becomes unduly heated. With 1250 ohms, 60 m.a. drops only 75 volts, which is more reasonable. The voltage drop table in the Reference Section will show these losses at a glance.

When the resistance of a field winding is halved by re-winding with heavier wire, there will be half the number of turns, and consequently the inductance drops to one quarter of the original, but usually it will still give sufficient smoothing.

When the field has a high resistance such as 8000 ohms, it is energised by a "bleed" current of 15 m.a. or thereabouts from the "B" supply, a wire resistor of about 10,000 ohms being required in series on a 250-volt supply.

A Judging Test.

The difficulty of judging quality is well illustrated by the following. Over 400 students at the New York University were invited to listen in turn to four hidden receivers and write down their preference in quality. Actually, only one receiver was used, being turned on four times. Most of the students gave preference for numbers 1, 2, 3, or 4, but only 28, or 7 per cent., recorded on their voting slips that all sounded alike!

The "Radio Times"

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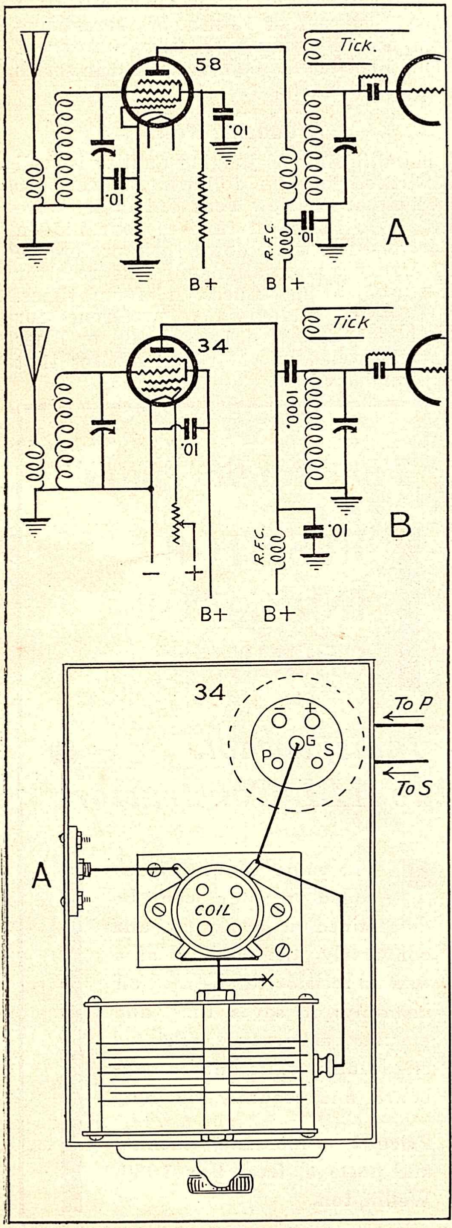
ADDING AN R.F. STAGE TO A SHORTWAVER

MANY owners of short-wave sets in which the detector is the first valve will be contemplating an extension, chiefly by adding an r.f. stage, which forms the readiest means of increasing the reception range. The extra stage should be tuned, and must employ a screen-grid valve, either a.c. or battery. Untuned stages and triode valves are scarcely worth while, as at the best their amplification is very slight.



Circuit and layout of the short-wave unit.

By building a small separate unit that may be placed close to the left-hand end of the receiver, and connected to the aerial terminal of the latter, the only alteration to the existing set is the matter of providing filament and plate current for the extra stage. In a battery circuit this is a rather simpler matter than in an a.c. set, though in the latter case, if the power-pack can supply the extra filament—as is most likely—no complications will arise.

The whole unit may be built inside one of the handy aluminium boxes that can be purchased for the purpose. The condenser should be the same as the one already in use to tune the detector circuit, and is mounted on the front end of the shield box. If the set is battery-operated the rheostat will be placed at one side below the condenser dial, which may be plain or vernier. The latter is best, of course.

Behind the condenser is the coil socket, which is better if mounted on a square of ½in. wood to raise it above the metal. Place the coil so that there is plenty of room all round, allowing free access for the hand when changing. Further back, in the centre, or in a corner, is the r.f. valve, which is covered with a shield can.

The aerial connection is provided for on a slip of ebonite bolted to the side of the shield near the coil and connecting to the top of primary.

The Additional Coil.

Secondary turns on the coils should be exactly as those on the detector coils, and the only other winding, the primary, is placed ⅛in. from the secondary. The ends of the two windings next to each other are the high potential ends; the secondary connects to the grid and the primary to the aerial. The other ends are both earthed. Primary turns, 24 d.s.c. or near that, are 4 (20), 6 (40), 8 (80), the metres being in parenthesis.

The plate of the r.f. valve is fed from the "B" supply through the detector primary coil, previously connected to the aerial, and between the primary and "B" supply there should be an r.f.c. of 8 or 10 millihenrys, with accompanying bypass condenser, and a reducing resistance of suitable value if the voltage is too high for the plate. However, if a 58 is used, 200 volts will not be too high.

The voltage on the screen should be about half that on the plate, and the lead to provide this is brought from the "B" supply. It includes a voltage-reducing resistance and by-pass condenser of .01 mfd. capacity on the valve side of the resistance.

If the metal box is raised on two strips of wood, leads may conveniently be run underneath. The plate and screen leads must be kept as short as possible outside the shield.

All that is necessary for an earth connection is to run a lead to the earth terminal of the receiver. The suppressor grid of the 58 is connected direct to the cathode, bias being provided by a 300-ohm resistor from cathode to earth, with the customary .01 mfd. by-pass condenser. If a volume control is required, a 20,000 ohm variable wire-wound resistance is placed in series with the cathode fixed resistor and earth.

The shield can should be covered by a snugly-fitting lid.

In the case of battery supply, the only difference from a.c. connections is with regard to the filament. Include a rheostat if necessary—it is usually convenient as a control.

In cases where the detector coil has only four pins, and there is no primary winding, the connection to the r.f. plate must be through the r.f. choke and then direct to the plate of the r.f. valve, connecting to the top of the detector secondary through a fixed .0001 mfd. condenser to prevent "B" current running through the secondary coil to earth.

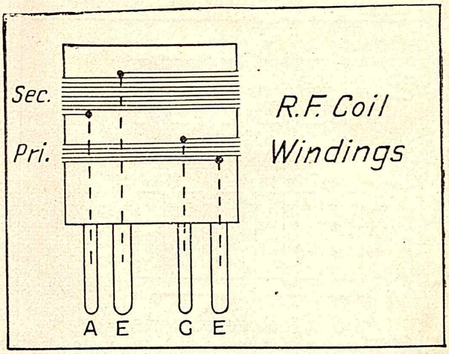
Valves.

If the receiver is run on a.c., there is no difficulty in selecting the correct valve —it should be a 58, which requires a six-pin socket. For battery operation the constructor must either select a valve with the same filament voltage as those already in use. Otherwise either a reducing resistance is required to be permanently connected in the filament circuit, or to obtain a higher voltage a separate filament supply must be used.

In the 2-volt battery class the 32 and 34 are suitable valves, especially the latter, which is a pentode, but as the suppressor grid is connected inside the valve, a four-pin socket only is necessary.

In operating this valve there may be great latitude in plate voltage, which need not be greater than that on the screen. Filament current is .06 amp. for both valves. A separate r.f. filament battery will pay if dry cells are used for the receiver, but where an "A" accumulator is used, a reducing resistance may be included in the 34 filament circuit if that is the valve to be used—66 ohms for 6 volts and 33 ohms for 4 volts, using a wire resistance capable of carrying 60 m.a.. and including a separate rheostat in the circuit.

For receivers using 5-volt valves, such as the 201A, the 39 is the valve to use. It is an r.f. pentode, indirectly heated, so the cathode is biased with a 500-ohm carbon resistor with .01 mfd. by-pass condenser.



The screen-grid of any valve used should be by-passed with a condenser not less than .01 mfd., but a larger capacity will be all the better if one is on hand. Connect as near to the valve socket as possible.

For short-wave only, a small solenoid r.f. choke is best, made as described in another chapter. Do not use a broadcast choke.

The minimum size of the shield box is 6in. x 4½in. and 6in. high, but 7in. back to front is better.

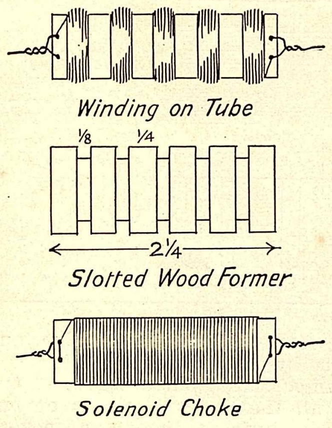
Diagram "A" shows the circuit used when the receiver is a.c. driven, and diagram "B" that for battery operation. The right-hand or detector portion of each is the same whether battery or a.c., the difference being that at "A" the coil coupling is "transformer" and at B "impedance" or "tuned anode" coupling. Either is interchangeable with either type of r.f. circuit.

WINDING RADIO-FREQUENCY CHOKES

THE importance of radio-frequency chokes in the modern receiver is too well realised by constructors to need much reiteration, but although much is known about their uses, a great deal less is known regarding their design and construction.

Desirable Features.

Any idea that a few hundred turns of wire on an old sewing-cotton spool is going to make an effective choke is a mistaken one, although with luck it might happen to function more or less as intended. Although an r.f. choke is merely a coil of wire, it must be carefully designed, and to that end much experimenting has to be done in order to produce a choke that is proportioned so that the capacity, inductance and r.f. resistance are suitable to give a high impedance at all frequencies at which it is designed to operate, and that it shall have no pronounced resonance, and thus be free from "dead spots." The latter quality is often the



R.F. Chokes

greatest stumbling-block in designing a choke, because when this trouble appears, small alterations in design will probably do nothing more than shift the position slightly, so that a fresh start must be made upon different lines.

The r.f. resistance depends upon the type of winding, size of wire and its insulation, and material (if any) with which the coil is impregnated in order to keep out moisture. The self-capacity depends upon the type of winding, impregnation, insulation, shielding, and position of leads —one should be at each end.

Self-capacity is the factor which contributes most to the inefficiency of a choke, and many expedients are resorted to in order to reduce it.

Since the early type in which the turns of fine wire were all run into one slot of a flat-shaped spool, there have been innumerable types of winding, chiefly resolving into divisions of the winding into several "pies," or sections, more or less separated. This construction, especially when the sections have a different number of turns each, is as much intended to overcome any tendency to resonant peaks or "dead spots" as anything.

The distributed capacity is the factor which greatly determines the inductance of the choke, so that two chokes, both having the same number of turns, differently wound, might have an inductance of 85 and 10 millihenrys respectively, the former having low self-capacity and the latter high. However, a choke depends for its properties mainly upon impedance, which falls off as the frequency rises, and should therefore be kept as high as possible (near resonance) at the lowest frequency to be received.

This is the chief reason why a choke should resonate at a point just above the band upon which it is to operate. Thus a broadcast choke should resonate at about 600 metres (500 k.c.), below which, as the higher frequencies are approached, its choking effect gradually falls off at a rate determined by the general characteristics.

That this falling-off is of a very gradual nature in a good choke is demonstrated by the fact that a commercial choke can be procured to operate satisfactorily between 2000 metres and 15 metres. Such a choke is produced to suit conditions in England, but it is certain that on short-wave such a choke would not function as well as one specially made to cover the short-wave range only, or even one made to cover all bands up to 600 metres.

When a high wavelength has to be reached, many turns of wire are needed, and to dispose these in a small space is the object in designing a choke. However, as thin wire is advantageous rather than otherwise, its use is an assistance in striving for compactness. One thousand turns of fine wire, 42 or 44 enamelled, disposed in various ways, will usually be sufficient to peak at about 500 k.c. Dead spots are not often found on high wavelengths, or on chokes of plain solenoid pattern, but on the short-waves, especially if the windings are arranged in sections, dead spots will appear.

S.W. Chokes.

For short-wave only, a choke should have an inductance of from 2½ to 10 millihenrys, and for broadcast down to 500 kilocycles, 10 to 85 millihenrys. A choke of this type may be used as an all-wave choke if the self-capacity is not too high. When possible, a special short-wave choke should be used so that full efficiency of the circuit is secured. One commercial all-wave receiver, at least, has been constructed so that the short-wave coils automatically put a short-wave choke into use. This could easily be arranged in home-built sets, because if the broadcast and short-wave chokes are connected in series, all that is required is a shorting switch across the broadcast choke to cut it out when bands below 80 metres are being received.

The best choke is that which has the highest inductance with low self-capacity and r.f. resistance—the latter will be three or four times the d.c. resistance.

Compactness reduces the chance of the external field coupling with that of other components in the receiver, but where space is limited, the choke may be wound "astatically" and placed in a small aluminium container. The objection to close shielding of a choke is that it encourages "dead spots," which are only removed after much experiment.

A very handy shield can is provided by an aluminium shaving-soap container, which may be reduced to the required length. Put a hole in the centre of the lid for screwing to the baseboard, and two holes, well separated, at the edge of the lid for leads. The choke is then placed in position, with a piece of crumpled tissue round it to space from the shield. The top cover is then put on. As with coils, the inductance is lowered by a shield; so extra turns, say 50 per cent. more, should be put on. Earth the shield only if necessary.

A shielded choke may also be wound in "polarised" form, as adopted for some unshielded patterns. This consists in separating the winding into from three to half-a-dozen sections, well separated, with a reduced number of turns on each succeeding section toward one end, so that the section at one end might contain 300 turns, the one at the opposite end would perhaps only have 180. To this latter, i.e., the smallest section, the r.f. connection must always be made. That is to say, the plate or other r.f. potential source connects to the small end.

It is always better, wherever possible, to arrange that the leads are kept at opposite ends of the former, and this usually happens in the case of a home-constructed choke without any great effort of design. Theoretically, the higher the frequency, the larger should be the gauge of wire used, but as an all-wave choke built on this plan would be far too bulky to include in the average set, very thin wire is used, without any appreciable difference in performance.

An Important Choke.

An important choke in a regenerative receiver is that used in the detector plate circuit to keep the r.f. currents out of the audio amplifier, and force them through the feed-back circuit. There are several circuits using this choke, as shown in the diagram, all applicable to broadcast or short-wave. No. 1 is the most frequently adopted, and requires a fairly high inductance choke, say, 85 mlh. for best results. No. 2 must have a very efficient choke, otherwise the feed-back current will be by-passed by the capacity of the audio transformer primary and little, if any, regeneration will be obtained. Two chokes are sometimes used in series in this circuit.

No. 3 obtains with electron coupling, where oscillation is procured without a tickler coil—a tap in the secondary, suitably connected, serving the purpose.

An r.f. choke is usually accompanied by a by-pass condenser, and in all r.f. circuits these components should be placed as close as possible to the r.f. transformer or socket to which they belong.

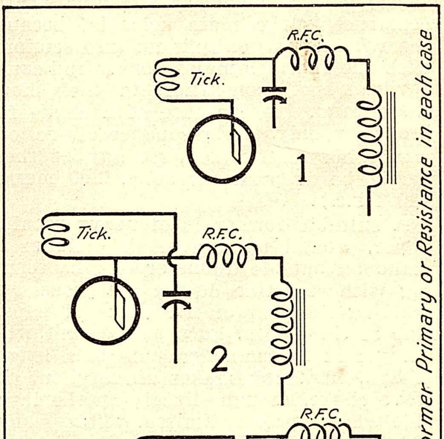
As a short-wave choke should have low self-capacity, double silk-covered wire may be used with advantage, and the gauge of wire may be slightly larger than that used for a broadcast choke, as it is theoretically correct for the gauge to increase with frequency. In practice this is not observed to any great extent, because compactness appears to have first consideration.

Sometimes an attempt is made in an all-wave receiver to place a broadcast and a short-wave choke in series, but when this is done, instead of any benefit appearing on the short-wave bands, the reverse is the case, because the two chokes merely act as one inductance, which now resonates at a higher wavelength than the broadcast choke alone. However, by the simple expedient of connecting a small fixed condenser, .0001 mfd. or less, between the junction of the chokes and earth, they will act independently. All the same, it is a better proposition to use a single choke that will function properly over the whole range.

Binocular Chokes.

The binocular, or dual astatic, form of choke is particularly good, because the method of winding tends to counteract the effect of nearby metallic shielding.

Two windings, each divided into sections, are mounted side by side, the two windings being opposed in direction, giving the "astatic" or neutralised effect to outside influences.



Three connections for a very important r.f. choke—that used in the detector plate circuit to prevent r.f. from reaching the audio amplifier—are shown in this sketch.

These chokes have usually a high d.c. resistance if of English make, because they are constructed to resonate above 2000 metres, and therefore contain a considerable length of wire. The self-capacity is very low, and in some cases down to .000002 mfd., which explains the high efficiency.

Except in the case of the solenoid, where the winding is plain sailing, sections should be piled in narrow slots as much as possible rather than spread out to any very appreciable width along the former. Winding in slots from ⅛in. to ¼in. wide, the narrower the better, keeps down the self-capacity.

Slots are most conveniently made by turning on a lathe, using a cylinder of dry, hard wood, or better still, ebonite. Whatever style of former is adopted, do not on any account have any kind of metal rod running through the centre of the windings.

Constructing Chokes.

The amateur constructor requires simple methods that do not entail the making of complicated spools, and the following specifications will be given with this idea in view.

The safest choke for the amateur to construct is the plain solenoid, because the winding is not split up into sections, each one of which may resonate and cause a "dead spot" somewhere in the short-wave band. In the case of a choke for broadcast only, this resonance of sections would not matter, because any of them would be at positions below 200 metres (1500 k.c.).

A suitable former is of heavy manilla paper, wound upon a small cylinder to make an outside diameter of ¾in., securing with seccotine during the process of winding the four or five turns of paper. One of these 3½in. long, and wound with a layer of 44 enamelled wire to a length of 3in., 800 turns, makes an excellent all-wave choke, though slightly on the large side where space is limited. This is suitable for the detector plate lead, or in fact, any position where space permits.

A choke suitable for placing in the power-pack high voltage leads from the transformer to rectifier is made upon a spool of flat formation. This is easily made by sawing off 3-16in. of lead-in tube, and glueing to each end of it a disc of strong cardboard 1½in. in diameter. Wind in the slot 1000 turns of the same wire as on the secondary windings, probably 36 gauge. If the transformer has an electrostatic shield between primary and secondaries, these chokes would in most cases bring no benefit.

A highly satisfactory short-wave choke to work from the highest frequencies down to 1000 k.c. consists of a solenoid winding of 470 turns of 44 gauge enamelled wire, occupying about 1.7in. on a ⅝in. former. This choke peaks at 1000 k.c.

Another excellent short-wave choke with a peak at 1500 k.c. and therefore good for use at higher frequencies than that, consists of a winding 2⅛in. long of 44 gauge enamelled wire on a test-tube or small glass bottle, ½in. diameter.

The 44 gauge wire is found in old audio transformers, and should be wound to cover the length specified, obviating the tedious operation of counting the turns.

Putting 1⅝in. winding of the same wire on a ⅝in. ebonite tube 2in. long produces a solenoid choke peaking at 910 k.c. (330 metres), so this would work up to 300 metres.

A good all-wave choke is made on a ⅝in. tube 2¼in. long, using 44 gauge wire, in five sections of 175, 250, 175, 200 and 250 turns respectively. These turns must not be allowed to spread out much, and will be better if wound in five slots ⅛in. wide and ⅛in. deep approximately, with ¼in. between each slot. A wooden former for this purpose would be ⅞in. diameter, reduced to ⅝in. in the slots. This choke peaks at about 420 k.c. and will therefore cover all bands.

Several years ago we designed a broadcast choke wound in five slots cut in four celluloid strips cemented to flat end pieces, with 200 turns of 36 gauge enamelled wire in each slot. This type of choke lends itself well to home construction, but is somewhat bulky for under-chassis accommodation. It is not detrimental for the winding to be of square or octagonal section, and this type will suit some constructors who wish to make formers without the use of a lathe.

Thicker wire must be used at the ends of these chokes, and the best method to follow is to put the end of it through two holes in the end of the former, afterwards soldering the end of the thin wire to the fixed part of the thicker one.

An occasional touch of seccotine while winding will prevent turns from slipping and afterwards hold them in place.

Section 5.

FACTS ABOUT EVERYTHING

Abbreviations (Code). The "ham" uses a long list of recognised code abbreviations, mostly of three letters, sometimes referred to as the "Q" Code because all the combinations have "Q" for the first letter. The list is an international code for all transmitters. "CQ" in morse is a general call sent out by a "ham" to attract the attention of another amateur in any part of the world. "QSL" is the code assigned to an acknowledgment, particularly the "QSL Card" sent out by an amateur in acknowledgment of a distant and helpful report on reception. A few of the abbreviations that the listener may sometimes hear are as follow:—

QRA, name or address; QRK, strength of signals; QRI, tone of signals; QRM, interference; QRN, static; QRO, increase power; QRP, decrease power; QRX, stand by; QSB, fading; QSL, acknowledgment; QSO, contact; QSY, change frequency.

When a transmitting station is sending test signals they usually consist of a series of Morse V's (dot dot dot dash), interspersed with the station call-sign. Many of the powerful automatic commercial stations keep their channels between periods of sending messages by automatic repetition of the call-sign. Although some of these powerful stations are at the other side of the world, they sometimes interfere badly with short-wave broadcast reception, because owners of t.r.f. short-wave receivers have to cater for volume in preference to high selectivity.

Absorption Wavemeters appear in various forms, but the basic circuit is merely a coil tuned by a parallel condenser. The coil is to cover the band upon which testing is being done, and one turn of the aerial lead is taken round the coil before entering the receiver. When the wavemeter dial is turned, at some point the signal on the receiver will be reduced in intensity, indicating resonance between meter and set. By finding the readings on the meter dial of the positions of a number of stations and plotting them on graph paper, a curve can be obtained that will show the position at which any other station may be received. Plug-in coils allow of any band being covered.

Accumulators or storage batteries are arranged to give 2, 4 or 6 volts for filament heating, or 100 volts or more for high voltage supply. The size of the battery, that is, the area of the plates, determines the amount of energy that can be stored, expressed in ampere-hours, 60 amp. hours being a popular size. The positive plates are a deep chocolate colour, and the negative, grey; any tendency to "sulphating," a type of deterioration, is shown as a white deposit appearing on the plates. When the charge is getting low, the chocolate colour of the positive plates tends to lighten. Never let the voltage get below 1.8 volts for each cell—5.4 for a 6-volt battery. When just charged, the voltage may be as high as 2.25 volts for each cell, but rapidly drops to 2.2 volts, soon settling to 2 volts, which is constant over most of the discharge period.

A hydrometer should be used to test batteries in addition to a voltmeter, because it reads the specific gravity of the acid and gives a good indication of the state of the cells. The usual s.g. of acid to be put into the cells is 1.18, or one part of sulphuric acid to four parts of distilled water. Always add the acid slowly to the water, not the water to the acid. When fully charged the hydrometer reading will be 1.22 to 1.24.

Keep the terminals clean and free from verdigris, and coat liberally with vaseline. A damp situation is unsuitable for batteries.

Keep acid surface at least ¼in. above top of plates, otherwise "sulphating" may take place.

Adaptor for short-wave reception is a short-wave detector which may be preceded by an r.f. stage; it plugs into the detector valve socket of a broadcast receiver, and utilises the audio amplifier. A "converter" changes the incoming signal to a fixed intermediate frequency by means of an oscillator as in a superhet.;

the r.f. stages of the broadcast receiver are then tuned to this intermediate frequency, becoming for the time being, an improvised superhet. circuit, giving very high gain which is further amplified by the audio stages.

Air-Cell Batteries of the "Ever-ready" type are filled with water when new, up to the bottoms of the filter holes. Four hours afterwards enough water is added just to cover the indicator wires. The liquid is maintained at this level by "topping-up" once a month.

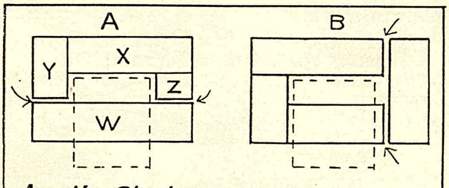
Aluminium is an extremely useful metal in radio work, and takes a pleasing, bright finish. This finish, however, is rather deceptive, for in spite of it there is always a thin film of oxide present on the surface of the metal, and this film has a high electrical resistance. For that reason, where connection is made to aluminium, any screw holding a wire should be screwed down as tightly as possible so that the metals are forced into intimate contact.

Ammeter, a meter which measures amperes, is not very useful for radio work, although voltage readings are frequently shown on cheap meters. It must never be used across any battery terminals, because the short, heavy wire coil amounts to a dead "short-circuit," which would ruin the battery. The cheap type of ammeter may be used to measure a.c. filament current, though its accuracy will be very questionable. For that purpose the meter must be placed in series in one of the leads. A milliameter is much more useful for radio experimenters.

Ampere-Turns. Electromotive force may be expressed in ampere-turns, and when it is desired to produce a magnet of a certain strength for perhaps a relay, a speaker field, microphone, or other instrument, if the requisite number of ampere-turns is known, the number of turns necessary to suit the current available may be calculated. Heavy current requires few turns of heavy wire, small current many turns of thin wire, both to produce the same effect in use. One ampere flowing through 50 turns gives the same magnetic effect as 50 amps. flowing through one turn, but it is clear that the gauge of wire must suit the current. Four amperes flowing through 120 turns of wire produces an m.m.f. of 4 × 120 = 480 ampere-turns, and the same m.m.f. would be produced by 2 amperes through 240 turns; 40 mills. (.04 amp.) through 12,000 turns would also produce 480 ampere-turns, with higher voltage to send the current through the high resistance. When the gauge of wire is settled and the resistance of the necessary turns found, the voltage to be dropped is calculated. The calculation of magnetic flux is an extension of the above.

Anode Bend. The louder the signal, the more efficiently it is rectified by this type of detector. If the r.f. input is doubled, the rectified signal will be multiplied approximately fourfold and in the same way a reduction of input results in a much greater reduction in the rectified output. On account of this, the effect of fading is very much accentuated by this type of detector. On the other hand, grid-leak detection tends to rectify a weak signal more efficiently than a strong one, and so minimise the effects of fading. The latter type of detector, however, will not handle without overloading anything like the signal the former will.

Audio Chokes are used chiefly for smoothing purposes in power-packs. Now that the dynamic speaker field is frequently utilised as a choke, only one auxiliary choke (if any) is required. For short-wave, smoothing must be much more complete than is generally considered suitable for a broadcast receiver. For this reason it is a good plan to construct for short-wave use a complete separate power-pack with double filter. This will supply filament and plate current for any receiver, and run an 8000 ohm field with a direct drain, also including a resistance of 10,000 ohms in series.



Audio Chokes

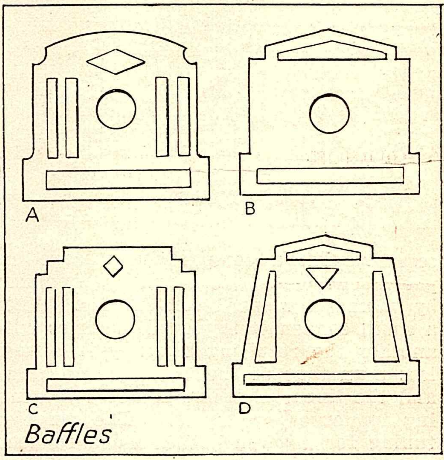
The core for a choke is made of stalloy as used for power transformers, but the strips are cut in a different way so that there are two "gaps" or small breaks in the continuity of the assembled core. In specifications often only one gap is mentioned, and if there are two, the given dimension must be halved for each gap. The gap is supposed to be an air-space, but for convenience it is generally filled with cardboard of the required thickness. A table in the reference section gives full particulars of chokes. The more turns and the finer the wire on a choke, and the larger the core section, the higher will be the inductance, but at the same time the direct current resistance must be kept down unless there is voltage to spare. For the average receiver of six or eight valves a pair of chokes of 7000 turns of 32 wire on a 1¼in. core will provide excellent smoothing.

Dimensions in the table are given for cores of pattern "A," but when the window is very narrow the form "B" is sometimes adopted to do away with the small piece marked "Z." With pattern "B" the two legs must project at least 1-8in. past the spool so that they are gripped by the clamp which passes over the length of the end-piece.

Automatic Volume Control, a system of automatic biasing in which, within limits, the carrier voltage applied to the aerial terminal of a set controls the output, is proving of great value in the latest automobile receivers. The variations in field strength which occur when a car passes between large buildings and through cuttings and valleys are automatically compensated for by the A.V.C., and the strength of reception is thus kept constant.

Background Noise. If present in the signal from distant stations, little can be done, but much noise originates within the receiver, and the greater the amplification, the more the noise is noticed. Something can be done to reduce it by working filaments or heaters at full voltage and by keeping screen voltages as low as possible without impairing results. Faulty valves will cause unnecessary noise. The variable-mu type gives quiet working. Losses in the transfer of signal from aerial to the grid of the first valve will increase noise, because more subsequent amplification is required. The usual closely-coupled aerial coil placed over the grid coil is efficient in this respect. Bad joints may give hiss that is considerable when amplified. On short-wave reception a considerable amount of background noise is produced locally, and in busy centres the ignition systems of numbers of motor-cars contribute quite a good percentage, although the nearest cars may be perhaps a quarter-mile from the receiver.

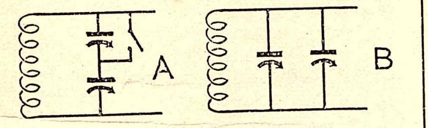
Baffle-Boards are still essential if a speaker is to give good volume on the low notes. The essential fact to bear in mind when designing a baffle is that it must not resonate. On this account the constructor should use one-inch thick timber for any size of baffle, rimu being a very suitable timber, secured with 2in. nails or screws. All joints should be closed at the back with strips of brown paper pasted on, and if of box pattern, the inside may with advantage be lined with felt or cloth. For the ordinary magnetic or midget dynamic speaker having a low note cut-off at about 100 cycles, a baffle 3ft. 6in. square is the largest necessary, but for a speaker that will reproduce down to 50 cycles a baffle 4ft. 6in. to 5ft. square is required for best results. Theoretically, the best size is 8ft. square. The effective size of a baffle is measured from the centre of the front opening, round the outside of the baffle, to the voice coil at the back. A large baffle need not be cut exactly square—the top may be rounded to add to the appearance, and the whole polished to suit. Although the flat baffle is the best, a compromise is sometimes adopted in order to save space by putting sides around the back of the baffle, which is equivalent to the extending the size of the square front, but as the addition of deep sides gives resonance that may be decidedly objectionable at some frequencies—noticeable in some cabinet receivers—the depth of the sides should not exceed 6 or 7 inches. An excellent baffle, giving pleasing deep-note reproduction from the popular 5-inch dynamic cones, is made of 1in. boards, with a front 2 feet square and sides 7in. deep. Thin 3-ply is not a suitable material for baffles or cabinets for speakers, but if used, should be heavily lined with felt or cloth.



Baffles

Four suggested ideas are given for large-sized baffles, which may be left plain, or ornamented with plain strips of 3-8in. wood. These strips must not cause rattle, and the best method to ensure this is to put a small square of cardboard or felt between the strip and baffle at each nail, or a strip of cloth cut small, running the full length. Otherwise the strips must be glued down very securely.

Band-spreading is sometimes resorted to in short-wave receivers, and consists in providing a condenser of small capacity that can be switched in series with the grid lead to the regular tuning condenser. A variable condenser is often connected in parallel with the tuning condenser to achieve the same purpose. The object is to facilitate tuning by eliminating the fine tuning necessary with a comparatively large capacity condenser. It is chiefly favoured by "hams" for speed convenience. When a small condenser is placed in series with another the resulting capacity is always less than that of the smallest one alone, and the linear characteristics of the tuning condenser are upset. The range of tuning for a given coil is much reduced, only the higher frequency portion being left available, so that the wanted band should be on the lower wavelength portion of the coil with the full condenser, so that it will remain in when the band-spreader is switched in. When not in use the extra condenser is merely shorted across, either with a switch in the case of a mica type, or if a small air dielectric midget variable, by bending a corner of one of the moving plates so that when full in it will contact a fixed plate and thus short itself out. Some constructors of all-wave receivers prefer to use, say, a .0003 mfd. condenser for broadcast, and reduce the capacity for short-wave work, in which case an extra short-wave coil will be required to cover the entire band.



Band Spreading

Tuning Condenser. Mfd.	Series Spreader. Mfd.	Resulting Max. Capacity. Mfd.
.0003	.0002	.00012
.0003	.00015	.0001
.00025	.0002	.00011
.00025	.00015	.000095
.00015	.00015	.000075
.00015	.0001	.00006

Another method is the "parallel," or "split-stator" with two variable condensers, say .00025 and .00005 with spindles in line, both connected in parallel. For broadcast both spindles would be locked to move as one, but for short-wave the larger condenser would remain at minimum setting, or as an alternative a switch is arranged to place the two in series for short-wave, connecting the two spindles with an insulated coupling.

Another method ("B") is to have two different condensers in parallel, say .0001 and .000025; the setting of the larger condenser determining the minimum capacity of the circuit.

It should be noted that spreading out the stations on the dial does not directly improve selectivity at all, and an adjacent interfering station will spread the same when the readings are widened. However, there is the advantage of being able to more easily tune in to the side-band of the wanted station farthest from the interfering one, and thus reduce interference.

Band Switches with several sets of six contacts each are now obtainable for all-wave coil switching, so that mechanical construction is dispensed with. This allows for four short-wave coils, and two sections for the broadcast, using the popular .00015 mfd. variable condenser for the purpose. One method of arranging the coils is to wind several on each of 5 or 6in. long formers, and another method is to make the coils all separate and mount them at various angles so that they will not resonate with adjacent coils. The latter method is the more compact, and allows each set to be within its own shield. Actually there is very little chance of trouble arising through "dead" coils being near the working one. The switches mentioned have six contacts and an insulated arm on each "bank," or insulated disc—one bank is required for every coil contact that is to be changed. Three sets of coils might require respectively 4, 3, and 2 contacts changing, total 9, which is the number of banks to be provided on the central spindle, yet the complete assembly is very compact.

Bass Notes require considerable power for audible reproduction, because the ear falls off very much in sensitivity below 100 cycles. From 4 to 6 watts output is necessary to reproduce effectively the notes between 100 and 40 or 50 cycles, and to do this efficiently, output valves must be capable of handling the volume without distortion. In addition, the output transformer must be specially adapted to supply the output to a suitable dynamic speaker, all impedances being matched as correctly as possible. When several watts output is stepped down through a 20- or 30-to-1 ratio, the current is considerable, and requires wire of reasonably heavy gauge to carry it.

Batteries, Dry "B." Up-to-date battery sets are capable of very fine reception, but it must be remembered that economy in the use of "B" voltage should be studied, because milliamperes may otherwise be wasted. The plate voltage will probably be the battery maximum on most of the valves, but too high a screen voltage means waste; there is a critical voltage at which amplification is maximum, above which voltage amplification falls off, but plate current continues to increase. Hence this optimum point should be found.

Beverage Aerial is a highly directional type of aerial, and consequently reduces interference. A usual length is 800 feet run on insulators along the top of a paddock fence, using copper or galvanised iron wire of heavy gauge. The aerial must be in a straight line and run from the house in the direction from which signals are wanted. The outer end is earthed through a resistance of approximately 750 ohms in the case of an aerial to cover 200 to 600 metres. The length of such an aerial would be 597 yards.

Buzzer. A buzzer, which should have a high-pitched note, is actuated by one or two dry cells. It may be used as a rough substitute for a valve oscillator, as the output may be tuned by a coil and condenser, and in this way any given frequency may be put out, once the range has been calibrated. A more popular use for a buzzer is for morse code practice, when it is included in series with a cell, a key, and one or more pairs of headphones. Learners may take turns at sending on the key, the others listening and reading the message. Two installations may be made in separate rooms and communication kept up between the two, each end taking its turn at sending.

Calculations. The following simple formulae based on Ohm's law should be memorised by every constructor:—

Watts = **Volts** multiplied by **Amps.**
Volts = **Watts** divided by **Amps.**
Amps = **Watts** divided by **Volts.**
Volts = **Ohms** multiplied by **Amps.**
Ohms = **Volts** divided by **Amps.**
Amps = **Volts** divided by **Ohms.**

Watts dissipated = **Amps** squared multiplied by **Resistance.**

When calculating with milliamperes in place of amperes, remember to add or take away three noughts as required.

Celluloid Cement is very useful in radio work for keeping short-wave coil turns in place, "doping" coils and formers, etc. It is made by dissolving small chips of celluloid in acetone, or, better still, a mixture of one part of amyl-acetate to two of acetone. The amyl-acetate is a better solvent than acetone, but more expensive. For thinning purposes the "thinner" sold for duco enamel can be used, but it will not do for the initial solvent.

Charging accumulators is a simple and certain operation if the necessary conditions are observerd. The voltage available from the charger must not be under 2.5 volts per cell to be charged in series, as each cell rises to this voltage whilst under charge, dropping to 2.25 when the charging current is cut off. Therefore the minimum voltage from the charger is 8 volts for a 6-volt battery, 10-cell 20-volt battery, 25 volts; 45-cell 90-volt, 115 volts; 56-cell 112-volt, 140 volts.

If an hydrometer reading is taken at intervals and each shows higher than the last, the battery is charging; when nearly complete, continue to take readings until there is no increase, which shows the charging to be complete.

If direct-current mains are to be used for charging, a number of lamps must be arranged in parallel to reduce the voltage. Carbon lamps of the correct voltage are used for this purpose, a number of sockets being connected in parallel

The "Radio Times"

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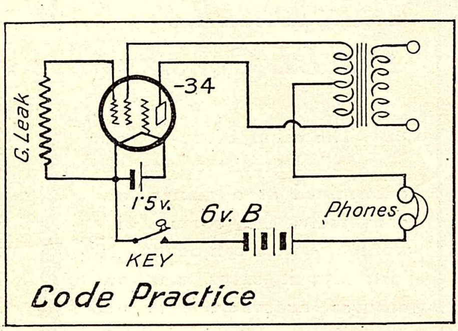
so that the amount of current passed is regulated by the number and candlepower (wattage) of lamps used. One side of each lamp socket connects to the negative mains and the other sides to the battery negative. Battery positive should be connected direct to mains positive. For a 6-volt battery 230-volt lamps would be used on a 230-volt supply, but for a 90-volt battery one 110-volt lamp of low wattage would be correct, or for test-tube cells a resistance of 1100 ohms to pass 100 m.a.

It is not a payable proposition to charge one 6-volt battery from d.c. mains, because most of the current is wasted in the lamps, but where a number of such batteries are placed in series and charged simultaneously the cost is much reduced.

By any method of charging, it pays to charge slowly, and not to exceed the rate recommended by the manufacturer, otherwise the life of the plates will be shortened.

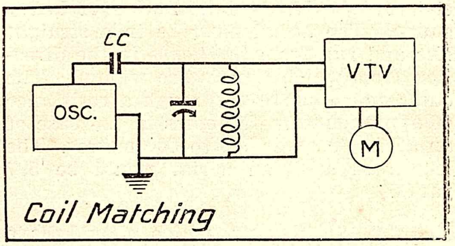
Code Practice. The Morse code may be easily learnt with the aid of a practice set and key. The simplest form is that comprising a buzzer, 1½ or 3-volt battery, key and 'phones, all in series. An audio oscillator gives an excellent note, and is hooked up as shown, operating on a 1½-volt cell for the filament, and 6 volts of flashlight battery for the "B" current. The transformer used is one with a centre-tapped secondary; the primary is not connected. The grid leak raises the tone as its value is increased—leaving it out and the control grid unconnected gives the highest pitch. Two people, each with a pair of phones in series, can take turns at sending and receiving

The proper way to learn code is to memorise it first as much as possible, so that you can translate any letter into "dah dit dah dit" (C) etc. Then get somebody to send short words—three per minute will be quick at first. Write every letter down, as you must get used to doing this. In two or three weeks at two hours a day, to receive 5 words of 5 letters each per minute is all that can be expected, and in a month it is possible to receive eight or ten short words a minute. Only then is it safe to take the key, as then you will know how the letters should sound, as they should be sent by somebody who is proficient. The above procedure will prevent a beginner from acquiring a bad "fist." The amateur examination requires twelve words per minute.



Code Practice

Coils, Matching. A reliable oscillator and a vacuum-tube voltmeter are necessary, connected as in the diagram. The coil to be tested has its appropriate condenser connected across it and set "full in" for maximum reading. Then the oscillator condenser is turned until the maximum reading is shown on the milliammeter, and the reading on the oscillator calibrated scale gives the lowest frequency or highest wavelength to which that coil will tune with the particular condenser. The milliammeter reading is adjusted to keep within range by the amount of coupling at "CC." in oscillator diagram. With the tuning condenser full out, the minimum coil range is found. If the coil is to be shielded in the receiver, the shield must be placed over it when testing.



Coil Matching

Compression Condensers directly mounted upon a metal chassis or panel are thereby liable to have their minimum capacity raised, owing to capacity between the lower condenser plate and the metal mounting. Where the minimum setting is important, a chip of ebonite under each end, or a small length of lead-in tube round each fastening screw, will reduce any unwanted capacity.

This type of condenser may often take the place of the fixed variety where a variation of capacity may allow of maximum efficiency being obtained.

Cone Speakers (magnetic). Thin, hard, paper cones accentuate the high notes, static, background noise, and needle-scratch. By using soft, thick paper a more mellow tone is secured, especially if the output valve is a pentode. A small fixed condenser across the speaker coils is also useful in reducing superfluous high frequencies, or screechiness. The value should not be greater than .01 mfd., but probably a value around .003 will be found suitable.

Coupling-Condensers in resistance-coupled circuits should be of good insulation resistance, because a leakage of "B" current may put on the grid a positive bias that will quite cancel out the negative bias intentionally provided and thus provide an unsuspected source of bad quality. In addition, if the output valve is operated with much less bias than the rated value, it would soon be ruined.

Dead Spots are often met with in short-wave receivers—they are points on the dial at which the set will not oscillate. This trouble is usually caused by absorption at that frequency by the aerial circuit, which happens to resonate at that point. A small variable condenser in the lead-in moves the tuning of the aerial to another part of the band where there are no wanted stations. Sometimes it answers quite well to tune the aerial with an ordinary series broadcast wavetrap. When the detector is preceded by an r.f. stage there is less liability to dead spots.

A few dead spot locations exist in most countries, reception being practically impossible within a certain small area.

Drill Chucks. The chuck of the small hand-drill may get out of order, making it difficult to insert the drill. Take out the small screw in the side, and the head of the chuck can be screwed off. Inside are three wedge-shaped pieces connected together by three small spiral springs. Probably one or more of these springs is broken; if so, springs may be improvised from a piece of 28 nichrome resistance wire, wound round the shank of a drill of suitable size. Assembling is a finnicky job, but if the wedges are held point up in the fingers, the outer part of the chuck may be dropped over them.

Dynamic Cones. Unless the diaphragms can move freely in and out, the low notes may be restricted. A surrounding ring of soft leather gives the best results. Celluloid cement is the most suitable adhesive for repairing loose edges of cones, or for doping the turns on the moving coil itself. Some speakers that have been in use for a considerable time may develop a rattle that defies location. This may be due to a resonance developing in the cone, causing a portion to vibrate independently at harmonic frequencies. A simple cure is several coats of rubber cement over the whole cone, allowing an hour for drying between each coat.

An obtrusive "boom" on bass notes indicates faulty design in the speaker. The voice coil should be positioned so that the whole of the winding is within the gap. If this is so, the impedance of the coil will be fairly constant at all frequencies; if not, impedance will alter considerably with frequency, so that at one end of the scale matching to the output valve will be to some extent upset.

Earth Connection. This should be treated as being just as important as any other part of the receiver circuit. Although many mains-driven receivers will function without a proper earth connection, yet when it is provided, hum may be reduced, and reception generally be quieter, because there is no doubt that a good earth is a factor in reducing local interference. The chief methods of providing an earth are (a) connecting to a high-pressure water-pipe; (b) to a metal plate sunk in the ground; (c) to a metal pipe driven several feet into the ground, descending to where there is always moisture, say to six feet; (d) to a substantial wire (12 gauge), sunk in the ground two feet or more below the full length of the aerial. Any of these may be supplemented by a metal container holding chemical matter to percolate into the ground and make it more conductive, to be connected at the underground end nearest to the receiver.

For (a) it is too difficult for an amateur to solder a connection, so scrape clean and attach a screw clamp; a few pieces of tinfoil under the clamp will keep the pipe clean and help to improve the connection. Examine and clean every few months, especially in damp situations. For (b), a copper plate two or three feet square is ideal, but expensive. A sheet of old roof-iron answers well; cut a one-inch strip along one long side, but do not sever at one end; this is the lead which should be brought above the ground. The end should be drilled, the earth wire bolted in place, and the end also soldered. Bury in a vertical position, resting on one long side. (c) Explains itself. Use one-inch or better still, one and a half inch pipe. Solder the earth wire near the top before driving. Water may be poured down to render the ground more conductive. Any earth lead should be 14 gauge or heavier—it is a good plan to use the wire double. Avoid soldered joints underground, but when made, two or three liberal coats of duco enamel will greatly prolong their life. The same remarks apply equally well to joints in the aerial.

Connection to an artesian well pipe gives the best possible earth connection, provided it is not too far away from the receiver. Several driven pipes or other devices may be connected together to act as one earth, but the distance between each and the earth lead-in should be as nearly equal as possible, a wire from each converging to the junction.

In cases of bad electrical interference, it sometimes happens that the noise arrives at the receiver through the earth connection, and in such case a counterpoise earth should be used. This is a replica of the aerial, insulated as completely, and slung between the aerial poles a few feet above the ground. The insulated lead-in connects to the earth terminal of the set. Those who specialise in DX reception will be well repaid by improving the earth connection.

Earth with A.C. Sets. Listeners sometimes find that the removal of the earth wire from an a.c. receiver makes no difference to its performance, and sometimes think that perhaps something is wrong. The fact is that one of the a.c. mains is actually connected directly to earth, so that there is a radio earth still available when the earth wire is removed, though actual performance may not be quite as good on distance, and there may possibly be a little more hum. For best and consistent results a good radio earth should be provided independent of the mains. Some short-wave a.c. sets actually do give greater sensitivity and consequently greater volume with the radio earth disconnected. Hence if the set is an all-wave receiver, an on-off switch should be fitted in the earth lead for convenience. In other cases greatest sensitivity and reduced hum may be obtained by earthing an a.c. set through a 2 mfd. condenser.

Earthing Short-Wave Sets. When constructing a short-wave receiver it is up-to-date practice to see that all earth connections are made direct through copper to the earth terminal. This is best effected by running a heavy copper wire or strip from the earth terminal to the opposite end of the chassis. Then all earth connections can be made to this. Also run a wire direct from the earth end of the detector secondary coil to the rotor of the tuning condenser as well as to the earth wire. It often reduces mysterious noise that is difficult to locate if the detector condenser is insulated from the panel and earthed as above to one point only.

Electric Clocks may be run from alternating current supply, and consume a negligible amount of current. They are handy in conjunction with a.c. sets if suitably connected so that the supply to the clock is not broken. A tiny synchronous motor turns the mechanism. The time-keeping is good, because the frequency of the mains is carefully checked, and any slight error of a second or two is gradually corrected during the following few hours.

Electric Supply. Those who are interested in checking up the amount of mains current consumed by their receivers, transmitter, etc., will find this table useful. The first column shows the watts consumed, the second the current, and the remaining two, units against time.

Electric Supply

At 230 v. Watts	Amp.	Unit per Hour	Hours per Unit
40	·173	·04	25
50	·213	·05	20
60	·26	·06	16·6
70	·30	·07	14·3
80	·34	·08	12·5
90	·39	·09	11·1
100	·43	·1	10
120	·52	·12	8·3
140	·61	·14	7·1
160	·7	·16	6·3
180	·78	·18	5·5
200	·87	·2	5·0

Electrical Interference is best cured by taking preventive measures on the interfering apparatus itself, where this is possible. In the case of vacuum cleaners, electric motors and dynamos the usual procedure is to connect a pair of 1 or 2 mfd. condensers in series across the brushes or terminals, another connection being made from a point between the two condensers to the frame of the machine. In the case of vacuum cleaners or small motors such as they contain, a 1 mfd. connected across the brushes is often all that is needed. Condensers must always be of test about double the voltage to which they are subjected. Electric signs are sometimes a difficult problem. In any case where the interference is severe, it may be prevented from radiating through the mains by placing a suitable choke in each lead; made of wire suited to carry the current, and of turns sufficient to act as an r.f. choke. An efficient solenoid choke for such a purpose to carry up to 6 amperes consists of 150 turns of 18 d.c.c. wire on a 6in. former, 12in. long. By-pass condensers on a.c. mains should not exceed 1 mfd., but probably .1 mfd. or even .01 mfd. will serve. On d.c. mains 2 mfd. may be used, as no current will pass through the condensers.

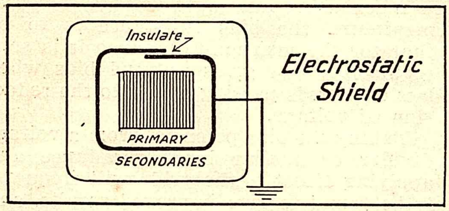
When a single condenser is used across the brushes of a motor it is often necessary to include in series a damping resistance of about 20 ohms. Brushes must, of course, be adjusted so that there is no sparking.

Sometimes a solenoid choke and condenser on one main (unearthed) only will clean up interference, but this is more likely when the house wiring is all in metal conduit, and one main is earthed at the switchboard. In such case the filter must be tried in each main in turn. When the house wiring is in wood casing, both leads are acting as aerials to pick up any nearby interference.

Electrolytic Condensers must always be connected with correct polarity, the positive electrode being plainly marked. If of the wet variety they must be held in a vertical position, connection end downwards. The dry type may be placed in any position, but do not possess the self-healing property that the wet type have. On account of polarity, neither type may be used in a.c. circuits, such as the reservoir capacities in voltage-doubling circuits preceding metal rectifiers. After the rectifier they may of course be used in any smoothing circuit.

An electrolytic condenser is not suitable for radio-frequencies on account of the alternating impulses.

Electrostatic Shield. This should be included between the primary and secondary windings of a power transformer, as it effectually reduces interference arriving via the power-lines. The device is merely a sheet of thin metal or heavy foil encircling the primary windings, but so insulated at the overlapping edges that there is no metallic connection there. A wire connects the shield to earth. Insulation between the shield and windings must be thorough.



Fading does not present quite as difficult a problem as static. With two aerials not far separated, fading may occur on one and not on the other at the same time. This fact gave Beverage the "diversity reception" idea, where three separate aerials may be used for reception. It was found that in this system signals were out of phase, so all three are rectified so that they can be combined without synchronising, and thus a fairly constant signal is produced. Automatic volume control prevents fading, but only down to a certain level.

"Ferrocart" is a core material for r.f. coils, giving high efficiency compared with the usual air-cored type. Iron filings are sprinkled over strips of adhesive paper, drawn under a kind of comb to arrange them in lines, then through a d.c. current-carrying solenoid to align all the particles, which are then allowed to set in position. The strips of paper are used as laminations to build up a core. Coils are wound upon it much in the style adopted for audio chokes, employing sectioned spools. Efficiency is produced by eliminating loss, and compactness is an important feature. "Nicore" is the name of a similar product.

Field Resistance. The usual resistance of a dynamic speaker field is 2500 ohms, and by passing the whole of the high-tension supply through this after rectification it can take the place of the two smoothing chokes usually placed in a power-pack. Thus considerable space is saved when the power supply is incorporated in the receiver. An electrolytic condenser to stand high voltage and of 4 to 8 mfd. capacity is usually placed on each side of the field. On the small-sized speakers the field winding is of 38 to 40 gauge wire, so there is a considerable rise in temperature if 35 to 40 m.a. is carried, but this need cause no concern. The more important matter to watch is the inevitable drop in voltage of the whole plate current supply, especially if it is bordering upon the amount mentioned. Here are the exact losses of voltage, which vary in proportion to the current passing:—

Milli-amps.	Volts Lost.	Milli-amps.	Volts Lost.
10	25	50	125
20	50	60	150
30	75	70	175
40	100	80	200

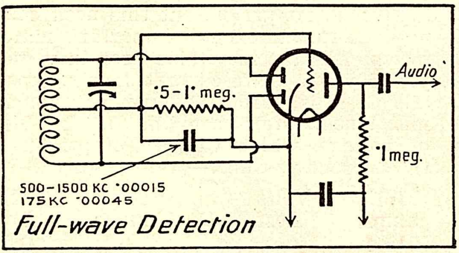
From this it will be seen that if the usual 250 volts is to be supplied to the receiver after smoothing there should be an average margin of around 100 volts, and it is for this reason that most small power transformers have now an initial high voltage of about 375. It should also be noted that if the total "B" current is to be more than 30 to 35 m.a., it is advisable to provide a field containing heavier wire than mentioned above, so that undue voltage is avoided. In any case the larger speaker will be more suited to a receiver taking heavy "B" current.

Where an existing a.c. receiver has a magnetic speaker and a dynamic is desired, it is possible by substituting an 82 rectifier for the 80, to gain at least 50 volts, and thus compensate to a great extent for the loss of voltage occasioned by the drop in the speaker field. When this is done, it is necessary to see that the working voltage of the condenser following the rectifier is still sufficient, and provision must be made to reduce the filament voltage of the rectifier to 2.5 volts. This is best done by placing in one side of the filament circuit 4½ inches (plus sufficient for connections) of No. 26 B and S nichrome resistance wire (1 ohm).

When a direct drain is to be taken from the power supply to energise the speaker magnet, the field must have a resistance of 8000 ohms, and in series with this there must be a resistance (say 10,000 ohms) to restrict the drain to 10 mills. One side of the winding is connected to earth.

Filter, Low-pass, is designed to pass currents of all frequencies below a critical or cut-off frequency, and substantially reduce the amplitude (volume) of all frequencies above this critical value. A high-pass filter is the reverse of this.

Full-wave Detection. The 55 is a suitable valve, giving two diode detectors, or rectifiers without amplification. The diode plates can be used separately for full-wave, or paralleled for half-wave detection. The latter will give twice the rectified voltage compared with the full-wave connection.



Full-wave Detection

One diode plate may be used for detection and the other for automatic volume control. The triode section may be used for the first audio. The usual number of secondary turns is put on the tuning-coil, but a centre-tap is provided. Connections are shown in the diagram. An alternative method dispenses with the secondary centre-tap and employs an extra centre-tapped coil, the diode plate being connected to the respective ends.

Grid Bias is negative potential applied to the grid of a valve in order to prevent "grid current," which causes waste and distortion. The grid may be made directly negative with a few dry cells, or the equivalent may be obtained in an a.c. valve by making the potential of the cathode a few volts positive with respect to earth, and this is accomplished by inserting a resistance in the cathode lead to earth. To find the correct value for this resistance take the plate current in mills, and if there are screens in the valve, add their current to it assuming that the highest plate voltage is applied. Divide the mills. so obtained into the bias volts required, and the result is the value of the resistor in ohms. The following values have been calculated from the manufacturers' latest ratings, and show the minimum bias resistor value. The general practice is to use the next even stock resistor slightly higher, but in the case of power valves the increase should only be small. Radio-frequency valves are often biased as much as 100 ohms extra in order to secure stability, but at the same time sensitivity is sacrificed. A variable resistance of 20,000 ohms or more in series with the minimum bias resistor gives good control of volume and sensitivity.

BIAS RESISTORS (MINIMUM).

Valve.	Ohms.	Valve.	Ohms.
35	350	50	1500
57	1200	53	850
77	1000	59	1100
39	420	71A	2100
44	420	89	1000
58	300	2A5	408
78	225	6A4	580
2A7	215	38	1000
6A7	215	41	480
2B7*	270	42	400
6B7*	270	43	490
2A3*	750	47	440
2A3†	700ea.	59	400
10	2200	89	680
45	1600	227	2250
56	2700		

*As amplifiers; †Push-pull triodes.

When using less plate voltage than the maximum, the bias resistance is to be that for the maximum, because it is self-regulating, and gives reduced bias when less current is passing owing to the reduction of voltage.

Taking the bias potential from a voltage divider or similar bleed resistance and applying direct to the grids will frequently be found to give improved results, and this remark includes the r.f. stages.

When a grid-bias battery is used, the negative end is connected to the transformer secondary terminal marked "G.B." or "Fil." and the positive to earth.

With a "plate" or anode bend screen-grid detector used for both broadcast reception and pick-up, provision should be made for reducing the usual 25,000 ohm bias resistor to 5000 when the pick-up is being used, so that quality is preserved in both cases.

A by-pass condenser of liberal capacity is placed across bias resistors for single valves, but is not required with push-pull output, in which case the two cathodes or filaments are earthed through a common resistance. This is exactly half the value of that for a single valve, because double the current is passing.

The self-bias resistors for three duo-diode valves under various operating conditions as self-biased detectors are given here, the plate mills. being shown in parentheses after each resistor, 180 volts on the plate in every case.

Grid Res.	55 ohms.	2A6 ohms.	2B7 ohms.
.25	16,300 (.46)	4900 (.25)	3700 (.43)
.25	28,000 (.25)	7100 (.17)	7600 (.26)
.50	14,900 (.47)	5450 (.24)	3500 (.45)
.50	31,200 (.24)	9000 (.14)	7300 (.26)

Ground Waves are sent out by every transmitter. They travel along the surface of the earth, passing through mountains and bush, being considerably weakened in the process and finally becoming non-existent at distances depending on the frequency and power. With the ground-wave only there would be no long-distance reception, even at night, without the existence of a sky-wave also. The lower the frequency, the further does the ground-wave travel. A 2000-metre wave travels as far over land as a 200-metre over sea.

Harmonics. At close quarters, any transmitter can be picked up on a number of higher frequencies than the fundamental. Near a powerful broadcast station at least twenty harmonics may be located on the dials of a short-wave receiver. As these harmonics, when identified, give the position of a definite frequency on the dial, they form very convenient "landmarks" to assist in locating the position or approximately determining the frequencies of adjacent stations. By tracking up the harmonics of a broadcast station on a short-wave receiver which is then made to oscillate, an oscillator may be tuned into resonance and thus calibrated, each dial position of the oscillator being plotted on a graph, and the points joined by a curve.

Twenty harmonics for the four main stations are given so that experimenters are saved the trouble of calculating them.

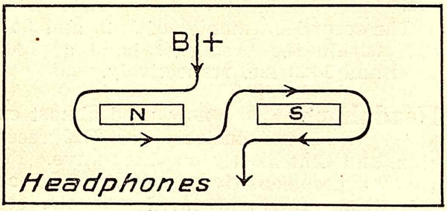
Harmonics are calculated by dividing the fundamental wavelength by 2 for the second harmonic, 3 for the third, and so on. Working on frequencies (kilocycles), the fundamental is multiplied by 2 for the second, 3 for the third harmonic, etc.

The second harmonics of 1, 2, and 3YA fall within the broadcast band at 1300, 1140 and 1440 k.c. respectively.

Broadcast Harmonics

	1YA		2YA		3YA		4YA	
Har.	Metres	kc.	Metres	kc.	Metres	kc.	Metres	kc.
Fund.	461·3	650	526·0	570	416·4	720	379·5	790
2	230·65	1300	263	1140	208·2	1440	189·75	1580
3	153·76	1950	175·3	1710	138·8	2160	126·5	2370
4	115·32	2600	131·5	2280	104·1	2880	94·87	3160
5	92·26	3250	105·5	2850	83·28	3600	75·9	3950
6	76·88	3900	87·7	3420	69·4	4320	63·25	4740
7	65·9	4550	75·14	3990	59·48	5040	54·21	5530
8	57·66	5200	65·75	4960	52·05	5760	47·44	6320
9	51·255	5850	58·4	5130	46·26	6480	42·17	7110
10	46·13	6500	52·6	5700	41·64	7200	37·95	7900
11	41·936	7150	47·8	6270	38·76	7920	34·5	8690
12	38·44	7800	43·8	6840	34·7	8640	31·625	9480
13	35·3	8450	40·46	7410	32·03	9360	29·19	10,270
14	32·95	9100	37·57	7980	29·5	10,080	27·08	11,060
15	30·75	9750	35·06	8550	27·7	10,800	25·16	11,850
16	28·8	10,400	32·8	9120	26·02	11,520	23·72	12,640
17	27·13	11,050	30·9	9690	24·5	12,240	22·32	13,430
18	25·63	11,700	29·22	10,660	23·13	12,960	21·08	14,220
19	24·43	12,350	27·68	10,830	21·9	13,680	19·6	15,010
20	23·06	13,000	26·3	11,400	20·82	14,400	18·975	15,800

Headphones are now used almost exclusively for DX reception, and that mostly on short-wave. For that purpose sensitiveness is the first consideration—fully saturated magnets, correct spacing of the diaphragms, and correctly proportioned coils will assure this. The usual d.c. resistance is 2000 ohms for each earpiece, or 4000 ohms per pair. A diaphragm not too small in diameter gives greater sensitivity and deeper tone. The diaphragm must be adjusted so that its distance from the magnets is only equal to the thickness of a piece of paper. Much rattling indicates too small a space, but any phones will rattle on excessively loud signals. It is better for the phones and for the plate current if the latter is not passed through them, but is by-passed through a choke, and the signal alone fed to the phones through a 2 mfd. condenser. By this method a reduction in output plate voltage is prevented, and the phone windings last much longer. If the windings break down it is not a very difficult matter to rewind, with the aid of a small hand-drill held in a vice to turn the spool. In replacing the spool it is important to connect it with correct polarity, and the best way to ensure this is to note connections and direction of winding, and follow these when replacing. To distinguish the magnet poles either a permanent magnet or a compass magnet is required. The north or marked end of either of these is attracted to the south pole of the earpiece, and repelled by the north, so their identity is easily established. When looking at the end of the magnet spool, the current is running clockwise on the south pole piece and the opposite way on the north, which is connected in series, as shown in the diagram. If no d.c. is to pass through the windings, the polarity is just as important, because the signal impulses must weaken or strengthen each pole at the same time, otherwise volume would be much reduced. The above remarks also apply to magnetic speaker windings. With no d.c. the outside connections to phones may be either way.



High Wavelengths. If a set is not capable of tuning as high as 526 metres (570 k.c.) it is necessary to add a certain number of turns to every secondary tuning-coil. In a set with separate tuning dials this is a comparatively simple matter, but for ganged circuits the coils must be correctly "matched" to the new inductance value. If reaction is employed, an extra turn or two may be required on the tickler so that the set may oscillate at the higher wavelengths. By raising the range in this way the receiver will not tune quite so far down on the low wavelengths, but will still cover the broadcast band if the condensers are not less than .00035 mfd. The average coil will require about 10 extra turns.

Another method is to increase the condenser capacity by an extra condenser in parallel, or if the variable condensers are less than .0005 mfd, by changing them for a larger size. The following table shows the capacity to add in parallel.

Coil induc. mch.	500 Metres.	550 Metres.	Add Parallel.
140	.0005	.0006	.0001
200	.00035	.00043	.00008
234	.0003	.00036	.00006
280	.00025	.0003	.00005

Hum may arise from the power supply, speaker field, pick-up from power-lines, filaments or heaters, leakage between heater and cathode due to high a.c. potential difference, etc. Locate the source by shorting first the input, then the output of each stage in turn. If it persists after the input of the last audio stage has been shorted, the trouble is probably in the power-pack or speaker. Short the output transformer or voice-coil, and any hum remaining may be in the field.

A .1 mfd. high-test condenser on each side of the power line to earth will reduce one class of tunable hum. Increasing the capacity of smoothing condensers may give considerable reduction. Try adding to each one in turn.

Audio transformers should be kept well away from any a.c. fields. Stray hum from the rectifier and filter choke may be picked up by the detector or audio valves. Sometimes it is an improvement to connect the speaker field, if used as a choke, in the "B" negative lead.

I.F. Transformers for superhets., now constructed with air dielectric variable condensers, are very efficient. A gain per stage of 200 is usual, giving a gain of 4000 for two stages—all the gain now required with the latest valves and other circuit improvements. A gain of 259 is possible where a single stage is used, but selectivity suffers if the gain is made too high, and very thorough decoupling of all adjacent leads is necessary.

Impedance Matching. Unless there is at least approximate matching between the output valve and the loudspeaker, really high grade reproduction is not possible. If all is in order, heavy volume should be obtainable without distortion.

Impedance is stated in ohms, but differs from direct-current resistance; it is equivalent to alternating-current resistance, or resistance to the signal component.

Dealing with magnetic speakers, the impedance should be double, or nearly double, that of the valve, taking it at 250 cycles as an average, because the impedance of a magnetic speaker varies according to the frequency reproduced. A small fixed condenser is often put across the windings to reduce the impedance at the higher end of the scale. The greatest transfer of undistorted power will be around the frequency at which the speaker impedance is about double that of the valve, usually 200 to 300 cycles, giving a fairly deep or "mellow" tone. If the greatest transfer of power is around 700 to 800 cycles, the general tone will be high, because notes at the lower end of the scale will tend to weaken. Speaker units are mostly designed so that the impedance at 256 cycles suits the average output valve of 2500 ohms impedance. Whether the speaker is connected directly to the plate of the valve, or through an output transformer or choke, the remarks apply, but only in the case of a small valve should the plate current be put through the speaker windings.

If two output valves are connected in parallel, the total impedance is half that of one valve, but if they are put in series (push-pull) the impedance is double that of one valve. Thus we find that even with large valves used in push-pull the total impedance is inclined to be high, and in order to match the speaker to this the output transformer or choke is tapped, and this is equivalent to raising the impedance of the speaker. If the ratio is 2-1, it is equivalent to multiplying the speaker impedance by 4 (2 x 2), so instead of the speaker giving its maximum volume at a frequency for which its impedance is 1600 ohms, the maximum power transference will now be at a frequency for which the speaker impedance is only 4000 ohms, though it is made equivalent to 1600 ohms by the tapping. With a 3:1 ratio the speaker impedance is equivalent to nine times (3 x 3), and it will thus be seen that with a suitable ratio the range of reproduction may be moved up or down to obtain the most desired quality reproduction. Increasing the impedance of the output transformer assists the reproduction of deep notes.

Concisely put, a step-down transformer steps up the impedance of the speaker, so that a 10-ohm dynamic speaker with a 10:1 transformer puts on the valve the same load as a 1000-ohm speaker directly coupled.

Speakers, like valves, have half the impedance when paralleled, and double in series, which shows that when one is switched off an equivalent impedance should take its place, or reproduction from the remaining speaker will be affected.

Provided that the voice coil is correctly positioned in the gap, the impedance of a dynamic speaker does not vary much with frequency, but if part of the coil is outside the gap, this does not apply. The output transformer ratio is calculated by dividing the speaker impedance into the load resistance and extracting the square root of the result, which gives the ratio.

Interference, Electrical. A band-pass filter with separate aerial primary will tend to reduce local interference better than when the aerial is tapped into the grid coil.

Kilocycles—Metres. The usual formula for ascertaining kilocycles or metres is to divide the known quantity into 300,000, which gives the wanted figure. This method, though very generally used, actually gives an error of 6 parts in 100,000. If the factor 299,820 is used, a more accurate result is obtained.

Wavelength = 300,000 divided by kilocycles.

Kilocycles = 300,000 divided by wavelength.

The following table gives a few leading frequencies, with equivalent metres and megacycles:—

Metres.	K.C.	M.C.	Metres.	K.C.	M.C.
500	600	—	42.86	7,000	7
400	750	—	37.5	8,000	8
300	1000	1	33.3	9,000	9
200	1500	1.5	30.0	10,000	10
150	2000	2	25.0	12,000	12
100	3000	3	20.0	15,000	15
75	4000	4	18.0	16,666	—
60	5000	5	15.0	20,000	20
50	6000	6	10.0	30,000	30

Linear Detector is one in which the rectified output is exactly proportional to the carrier-wave input. This is the case with the grid-leak detector, but with the advent of high-powered stations and the demand for heavy output, detector distortion has been overcome and amplification increased by using greatly-increased plate voltage, low grid-leak value, and small grid condenser (.25 meg. and .0001 mfd.), giving the "power grid" detector. When a screen-grid valve is used, the system of detection may be the same, but the amplification is much greater. The anode bend detector is non-linear, but with high plate voltage and heavy input (sometimes called

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a "power detector") it tends to become linear, though its disadvantages are that rectification is not complete, and distortion is not entirely absent.

Litz Wire or "Litzendraht wire" is used chiefly for special high efficiency broadcast tuning-coils. It consists of usually 3, 9 or 27 strands of fine wire, which may be enamelled, or single or double silk covered. The strands are twisted together and enclosed in an outer covering of silk. The strands are 36 gauge or finer. The object is to provide more skin surface than is afforded by solid wire, and thus reduce the r.f. resistance. Unless the wire is carefully chosen to suit the particular coil, little or no advantage may be gained. No advantage whatever is gained by using it for short-wave coils, because the strands are too closely coupled, and any possible gain is neutralised by what is known as "proximity effect."

Location has a very definite bearing upon reception of distant stations. The sea-coast is usually favourable, more particularly if the outlook seawards is towards the incoming wave as, for instance, the west coast of the South Island, and the Taranaki coast in relation to Australia. In such places it is often possible to receive Australian broadcast stations during daylight, whereas in less favoured localities such a feat would be impossible. The closely-built portion of a city is unfavourable on account of the network of overhead wires and numerous steel-framed buildings, all having an absorbing effect upon the waves to say nothing of the interference generated by tramways and electric machinery of all kinds. A high situation is usually good, but a hill close to the receiver on the incoming side may have either a slight or a severe screening effect. The presence of mineral deposits in screening hills may entirely obliterate signals. The same receiver taken to different localities often gives a surprising variation in performance.

Magnet Windings. Sometimes an experimenter wishes to construct an electro-magnet for a relay or other purpose, or to check up the polarity of phone or speaker windings. A handy rule is to remember that when looking at one end of the spool, if the current is running clockwiSe it is a south pole, and if aNti-clock it is, of course, a north.

Mains Aerials. Many English receivers have a "mains aerial" built into the receiver so that it may be switched in at will to use in place of the regular aerial. It consists of a small fixed condenser in series between the phase wire of the mains and the aerial connection, with a make-and-break switch included. When sold as a separate unit, there is a condenser in each mains lead, but the phase wire must be selected by plugging in the reverse way. Some users have had success and others the reverse, as reception depends upon the disposition of the house wiring and adjacent lines. The regulations are complied with if the condensers used are of undoubted reliability and 1000 volts test. This type of aerial is of no use for short-wave reception.

Measuring Voltages. A milliameter of good make, reading 2 milliamperes for a full-scale deflection, is a useful piece of apparatus for the experimenter to possess, as it can be turned to invaluable uses, not the least important being the function of reading any direct current voltages from fractions of a volt to thousands of volts. Any voltage is read by merely connecting the positive side of the meter to the positive source of potential, including in series a suitable value of resistance that will not allow more than 2 milliamps. to flow; the negative side of the meter is connected to the negative of the circuit to be measured. A resistance of 10,000 ohms in series gives 20 volts for the full scale; 100,000, 200 volts; the correctness of the reading depending upon the accuracy of the resistor used. The ordinary carbon resistor usually has a tolerance of ten per cent., which is too great for this purpose. The Ferranti wire-wound type is much more accurate, while for the carbon type, Graham-Farish are good where extreme accuracy is not essential. The error in carbon resistors is generally under value rather than over. Several resistors may be placed in series and a connection made at the required point.

Metal Spindles connecting ganged condensers or running through screen partitions, should be earthed by a spring contact at every partition, otherwise there is a danger of coupling the two circuits which the screening has been designed to prevent.

Microfarads. A farad is the unit of capacity, but as it is too large for ordinary use, the millionth part, or microfarad (mfd.), is used as the practical unit, and this again is divided into a millionth part, or micro-micro-farad (mmfd.), useful for stating small capacities. For ease in translating the latter into the former, a few leading capacities are given:—

Mfd.		Mmfd.	Mfd.		Mmfd.
.001	=	1000	.00008	=	80
.0005	=	500	.00005	=	50
.0003	=	300	.000025	=	25
.00015	=	150	.00001	=	10
.0001	=	100			

Microphones for stunts in the home are easily improvised in several ways. A magnetic cone, dynamic speaker (with field excited), headphones, or pick up may be connected to the input terminals of the amplifier transformer. and when spoken into, the voice will be reproduced by the amplifier speaker. In the case of the pick-up, a paper cup must be stuck on the needle, and the cup is spoken into, the usual pick-up connections being retained. The substitutes mentioned above all produce the necessary current when spoken into, so no battery is included in the circuit.

Miniature Speakers. To prevent trouble with bass reproduction in miniature dynamic speakers the resonance of the cone is raised to about 150 cycles by a decrease of weight and diameter, and by stiffening the surround and spider. By this arrangement there is excellent reproduction with good sensitivity between 100 and 5000 cycles, while up to 4 watts may be carried without overloading.

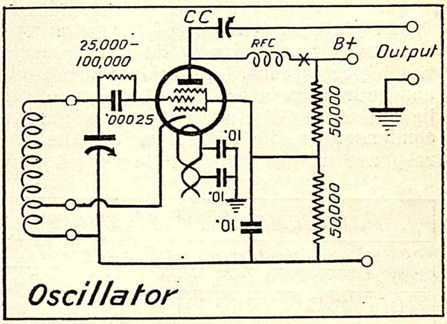
Modulation of the transmitted carrier-wave extends to 5 kilocycles on either side of the carried frequency, so that at the "peaks" of signals, the full 10 kilocycle channel is utilised if modulation is 100 per cent. In actual practice the limit is usually 80 per cent., because if modulation exceeds the limits of the 10 k.c. channel, there will be a heterodyne with the adjacent station on either side. If a carrier is modulated with a low percentage, in the case of a distant station the carrier will be well received, but as the signal is only weakly impressed upon it, reproduction will be correspondingly weak.

Multi-Reception. Several sets may each receive a different high frequency simultaneously from one aerial, if each receiver is coupled to the lead-in (inside the building) by a separate insulated wire, the free end being given 6 or 8 loose turns round the lead-in. The lead-in itself may be serving a broadcast receiver at the same time.

Non-Inductive Condensers should always be used as the coupling between a band-pass secondary coil and earth, because in some cases the inductive rolled type may have a considerable effect upon the capacity of its associated tuning-condenser, thus upsetting the ganging at one end of the scale. Another position in which this type of condenser should be used is the screen by-pass, because here the condenser has practically no impedance, while in the ordinary type the impedance may reach an unreasonably high figure for some purposes.

Oscillation, Audio. A good safeguard is to place a composition resistor of 5000 ohms or more at the grid of the output valve, and a wire-wound resistor of 100 ohms at the plate terminal of the valve—both connections as close to the valve as possible.

Oscillator, "Electron." As the experimenter progresses he begins to feel the need of a test oscillator calibrated to give any required frequency. Many oscillator circuits have been produced, but steadiness of frequency is of first importance, and this type fulfils that condition to a high degree. As shown in the diagram, it is operated by a.c., with plug-in coils. The condenser across the coils may be .0005 mfd. for the broadcast band, with either a series condenser or a separate .00015 mfd. condenser to switch in for short-wave work. The coupling at "CC" must be a very small capacity, .00005 mfd. or less, and as a rule two ends of insulated wire twisted together a turn or two is all that is required. The tap in the coils should be 1-3 of the total turns from earth. If oscillation is too violent, reduce the value of the grid leak. The resistors shown suit about 112v. "B," but can be altered as required. Adopt a straightforward layout, putting resistors and condensers under the base. Complete shielding often makes an improvement for some work. The 224 is a suitable valve.



Output. It is always as well to remember that the last valve in a receiver governs the maximum undistorted output. If a 171A is the last valve in a four-stage receiver, the addition of more r.f. stages will increase the range of the receiver, but the undistorted output will be exactly the same unless the 171A is replaced by a larger valve. Volume-carrying capacity is more important in an output valve than amplification, though in some recent developments both of these qualities are successfully combined, even to the extent of dispensing with a first audio stage.

Overhaul. Every receiver needs a periodical overhaul, say at least every twelve months, if its performance is to be kept up to maximum. Apart from the valves, general deterioration is going on in every part, and when we consider the great heat generated in many sets, the expansion and contraction caused thereby is bound to cause looseness to develop in many places, if nothing worse happens. In the following list, the parts first mentioned are liable to earliest replacements: Electrolytic and mica condensers, power transformer, variable resistors, fixed resistors, dynamic cone and voice coil, resistors, dynamic cone and field winding, general wiring.

Parallel-Fed Transformers. By keeping the direct plate-current out of the primary of the audio transformer, the inductance of the latter is considerably increased, with consequent greater amplification of the bass notes. By adjusting the coupling condenser to the correct value, the bass response may be further increased down to any given frequency, below which there will be a gradual falling-off. If the amplifier is also to reproduce gramophone records, a good frequency to arrange for is 60 cycles, owing to the fact that in the records amplitude decreases on the low frequencies. As a guide it may be stated that the primary inductance of the AF3 and 3C is 130 henrys and AF5, 5C, or 5CC, 200 henrys, all with no d.c.

Parallel-fed Transformers

Frequency Cycles per sec.	*Primary Inductance—Henrys*				
	50	100	200	300	400
100	·04 mfd	·025	·013		
80	·08	·04	·02	·013	·01
60	·15	·07	·035	·025	·02
50	·2	·1	·05	·035	·03
40	·3	·17	·08	·055	·04

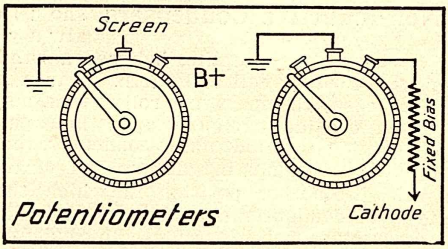
Pentode and Speaker. It is a feature of the power pentode that the power delivered to the speaker is the same at all frequencies, although in the case of a magnetic unit, the impedance rises steeply as the frequency rises. On this account the pentode considerably accentuates the high notes, and in the case of speakers with cones of paper—designed in the first place to boost the weakened high notes delivered by triode output valves—there should be compensation to reduce the intensity of high notes. Where the cone is made of softer material the necessity for compensation will not be so great, but is still necessary to suit most listeners. Such compensation also reduces background noise and needle scratch, and tends to soften the effects of static. Compensation, or tone control, may be effected with a fixed condenser only, from output valve plate to earth, or condenser and variable resistance in series across the output transformer primary, or a small tapped choke and condenser in series in the same position.

Plate Voltage Measurements. When taking a plate voltage reading it is quite usual to connect the negative side of the meter to the metal chassis or earth lead, but this method includes the bias in the plate voltage in the case of a.c. valves, so that a more correct reading is obtained by connecting the meter to the cathode, or in the case of a directly-heated output valve, to one of the filament terminals.

Polygonal Coils. A coil with four, six, eight or other number of sides is equivalent to a circular solenoid with an equal length of turn. To find the length of turn, measure with a narrow strip of paper, and divide the dimension so found by 3.14. The dividend will be the diameter of an equivalent circular solenoid, and from this the correct number of turns may be found in a chart.

Positive and Negative. Battery current is always taken as flowing from the positive pole of a battery and returning to the negative. Either red or a + sign is used to denote positive, and — or black or green for negative. Power lines supplying direct current are respectively positive and negative. One line is usually earthed. Alternating current supply has a "phase," or live wire, and a neutral, which is earthed, but polarity does not affect the working of most a.c. apparatus. When connecting up electrolytic condensers it is very important that the positive lead should be connected to the marked positive pole of the condenser, otherwise damage will result.

Potentiometers of high resistance, and usually wire-wound, are much used for reaction controls and for volume controls varying the bias on r.f. valves. The correct way of connecting is so that the knob is turned

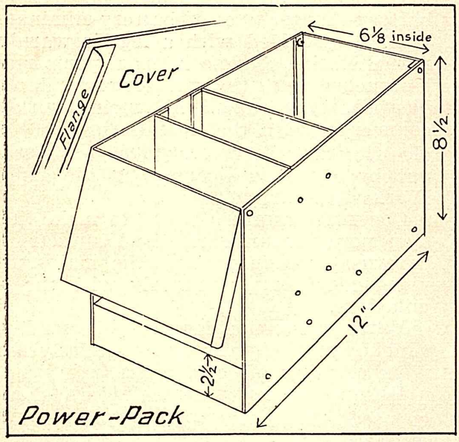


Potentiometers

clockwise to increase reaction or increase volume. A diagram shows a back view of the correct connections, that for bias control being used as a variable resistance with two connections.

Power Limitation. The power of European stations is limited as follows: Over 1000 metres, 150 k.w.; 545 to 272.7 metres, 100 k.w.; 272.7 to 240 metres, 60 k.w.; 240 to 200 metres, 30 k.w. Exceptions are: Moscow (over 1000m.), 500 k.w.; Budapest, Leipzig, Paris (PTT), Prague and Vienna, all 120 k.w.

Power-Pack. The standard type of container is made from 16 or 18 gauge aluminium, with a turned-down chassis as for a receiver. On each side of this is bolted a panel, and between these are fastened upright partitions with flanges, similar pieces being used at the ends, with screws at the top end to act as hinges. One partition contains the transformer in a horizontal position, another the rectifier, and another the one or two chokes, as required. The dimensions given accommodate the 110-watt transformer and the two 1¼in. core chokes. Smoothing condensers and connections are under the chassis. Dimensions should be altered, if necessary, to suit.



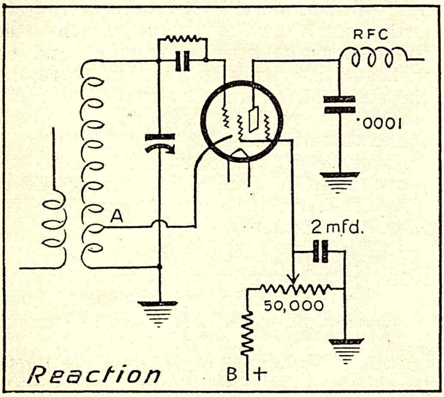
If shielded transformer and chokes are to be used, they may be mounted upon a chassis only, the sides being dispensed with. For greatest hum reduction, the axis of the transformer winding must be at right angles to the axis of any smoothing-chokes that are used, and the same applies to a speaker field if it is near the transformer.

Prohibited Earths include connection to electric conduit or earthing wires, or telephone earth wires. These would not be desirable earths in any case.

Radio Servicemen. A qualified serviceman holds a certificate showing that he has passed an examination to prove that he possesses the requisite technical knowledge to effect alterations and repairs to any radio receiver. He will always produce his "ticket" upon request. The examination also authorises him to carry out any electrical connections between a receiver and the wall socket or ceiling rose, and to replace the fuse-link on any sub-circuit supplying current to radio apparatus. Details of the examination, which is held twice yearly, may be obtained from the Assistant-Secretary, Wellington Employers' Federation, N.Z. University Buildings, The Terrace, Wellington.

Reaction may be found to fail around certain frequencies. Although oscillation may be obtained, no increase in signal strength might be noted. It is probable in such a case that oscillation is taking place at the frequency to which the reaction circuit is tuned by the reaction condenser and other capacities. This is more likely to occur when the number of reaction turns is excessive, and may be overcome by inserting between tickler and condenser a series non-inductive resistance of from 100 to 1000 ohms. An alternative is to rewind the tickler, using resistance wire.

One of the best circuits for obtaining smooth reaction in short-wave or broadcast receivers is shown in the accompanying diagram. It is known as "electron-coupling," and where reaction is already controlled by varying the detector screen voltage, little change is required to try it out. There is no tickler coil, and instead the bottom turn or two of the secondary is made to act as a tickler by connecting a tap to the cathode of the detector. In the average circuit mentioned, the only change, apart from tapping the coils and removing the ticklers, is to connect together the two leads that formerly went to the tickler, and to earth the cathode via the coil tap. Where the constructor may be left guessing is in the position of the tap on the secondary coil, so as a guide it may be stated that in the average receiver, reckoning from the earth end of the coil, the following tappings will be suitable: Broadcast, 2 to 3 turns (both coils, if two), 80 metres, 2 turns; 40 metres 1½ turns; 20 metres ½ to ¾ turn. On the 40- and 20-metre coils the best way to arrive at the tap position is to clean the wire for a distance each side of the expected position, and wind the end of a length of (say) 26 gauge wire twice round the coil turn. Then connect this to the prong of coil base slightly loosely. Now the position can be rapidly found by sliding the wire along, soldering when correct. An advantage of this system of coupling is that very little adjustment of reaction is required over any given band in use. Grid leak and condenser values should be tried out, as more sensitivity will probably be obtained if these are reduced, even to 1 meg. and .00005 mfd.



Transformer coupling to the previous plate is shown in the diagram, but the system works equally well with "tuned anode" coupling. In either case there is one connection less to the coil-former.

Regulations. The following points, mostly from the Radio Wiring Regulations, must be observed by radio amateur constructors:—

Power transformers must have a primary winding separate from other windings, that is, must be double-wound. Between the primary and other windings there may be an electrostatic shield earth connected, but in any case the insulation is to be undoubted. The primary wire must be of ample gauge to prevent undue heating. Condensers across mains must be of at least 500 volts a.c. test. Auto-transformers may only be used to regulate the supply to the primary of a double-wound transformer, and must be enclosed in metal.

All primary windings connected to the mains must be protected by a fuse in each conductor.

Power-packs, battery eliminators and chargers must be enclosed in a metal case, and if connected to the mains by a non-reversible plug may be fitted with a single-pole switch; if connected by a reversible plug, no switch must be included in the apparatus, and this also refers to receivers with built-in power-pack. Cases shall be adequately ventilated and connected to earth, and all connections carrying 100 volts or more shall be protected against accidental personal contact. A three-conductor cord is coloured—phase or live wire red, neutral black, earth white or any colour but black or red.

Apparatus operated from direct current mains must have a double-pole switch, and non-reversible plug adapter.

A receiver may be run from a flexible cord connected to a lighting point, or by a cord to a ceiling rose in addition to a lighting pendant, but in these cases there must be no switch on the cord or receiver, which could be connected in the later case with a lamp socket and adapter, or similar connector. Cords used in this way must be held across the ceilings and walls by insulated hooks.

Flexible cords to wall-plugs should be fitted with cord-grips.

Soldered or other joints must not be made in flexible cords: they may be joined with a lamp socket and adapter or similar connecter, but not the small porcelain type. Flexible cords should not be led into another room, or through a hole in walls or partitions.

Every set of apparatus other than a battery-charger or battery-eliminator shall be provided with a legible warning notice stating that no internal parts must be touched until the wall-plug or adapter has been withdrawn. All wiring work in connection with the installation of an electric radio receiver must be carried out by a person licensed by the Public Works Department.

Constructors are allowed to make their own power-transformers and similar apparatus for connection to the mains provided they comply properly with the regulations.

Earth connection may only be made to a cold-water pipe or to a specially-sunk plate or other piece of metal.

Bakelite sockets and adapters should be used; wooden adapters are not permitted.

Household and other electrical installations are inspected at periodical intervals.

Resin Flux in liquid form may be made by dissolving powdered resin in denatured alcohol, painting on the parts with a small brush. Keep well corked, and add alcohol to keep consistency correct.

Resistances used in receivers are mostly the "carbon" type, with wire "pigtails" attached, making connection an easy matter. The amount of current to be carried by the resistance must always be taken into account, as the carrying capacity of the carbon type is limited. It becomes less as the higher values such as 100,000 ohms are reached dropping to several milliamperes. If the resistance is around 100 ohms, 10 or 20 m.a. will be safely carried. Where heavy current is carried, as in the cathode resistor of a 56, or the output valve, long service is secured by employing wire-wound resistances, which are generally capable of carrying up to 100 m.a.

Carbon resistors are useful when "non-inductive" results are required, or if the wire-wound type is to fulfil this condition there must be an even number of sections, half of them wound in the opposite direction to the remainder. The carrying capacity of resistors is rated in watts, and within certain limits a resistor may carry small current at high voltage, or heavier current at low voltage. Elsewhere is given a table showing the rating of resistors required for a given voltage and current.

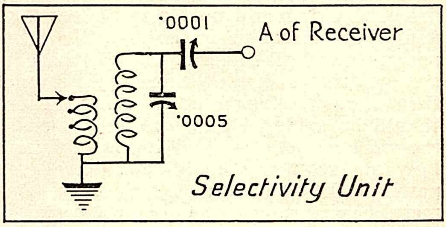
Resistance Rating. Carbon composition resistances now figure largely in the average circuit, and in order to ensure long life for these components it is only necessary to ensure that their capacity for current and watts is not exceeded. The higher the resistance, the less current it will usually have to carry, and this works out very conveniently in practice, permitting the use of resistors of 1-watt or even lower rating in many positions. For the guidance of constructors, a table is given in the Reference Section showing at a glance the rating necessary for a given current and voltage.

Suppose it is necessary to pass 3 mills. at 200 volts through a resistance of 100,000 ohms. In the table 100,000 ohms and under "1 watt," 3 mills is shown, and under "voltage, 1 watt," 315 volts is indicated, so that a 1-watt rating will be safe. Also, it is shown that a 5000-ohm resistor of 2-watt rating will safely carry up to 20 mills. at 100 volts, or we can make it 10 mills. at 200 volts, or 5 mills at 400 volts, as these proportions also equal 2 watts. These results are arrived at by multiplying milliamperes by volts, afterwards marking off three decimal places from the right because the calculation is in mills.

R.F. Chokes are easily constructed, but without reliable specifications a very inefficient component may result because the choke may possess one or more "dead spots" or "holes." A choke must not resonate at any frequency that it is designed to hold back, or "choke," but must have a resonant peak somewhat lower in frequency than the lowest to be received. Thus, a broadcast choke should not peak at less than 500 k.c., and may reasonably go to 450 k.c. or lower if for broadcast only. For an all-wave choke the same resonant point suits well, because by fixing it at too low a value we are only sacrificing some effect on the higher frequencies, where the full efficiency is needed. However, in England, where the long-wave stations have also to be covered, chokes are produced that will cover from 2,500 metres down to 15 metres.

Screws in awkward corners may be inserted by first sticking the slot of the screw to the driver point with seccotine or celluloid cement.

Selectivity of a broadcast receiver may be improved considerably by the use of a selectivity unit, which is just as efficient as a wave-trap for cutting out the local, and has the advantage that it adds selectivity to all parts of the dial range. In addition to the usual coil and air dielectric condenser in the ordinary series wave-trap, a .0001 mfd. variable condenser is all that is required, with the addition of about 10 turns of 30 d.c.c. wire wound on match-sticks over the lower end of the coil. This acts as a primary coil and is tapped from the bottom at 4 and 7 turns. The receiver connection from the top of the tuning-coil is taken through the .0001 mfd. condenser, which is of considerable assistance in cutting out an unwanted station on a nearby frequency. If a coil has to be made specially, a 2in. former wound with 66 turns of 26 d.c.c. wire is suitable for a .0005 mfd. condenser. Enamelled wire is not quite so efficient. Have both condensers on the panel.



Selectivity Unit

The same circuit is excellent to sharpen up short-wave reception when Morse interferes. It can be made to suit all wavelengths by arranging for plug-in coils, but in this case a .00035 mfd. condenser is the value for the large condenser, with a few more turns on the broadcast coil. A valve-base with 5 secondary and 3 primary turns of 24 d.s.c., 1-8in. apart, covers from about 20 to 50 metres.

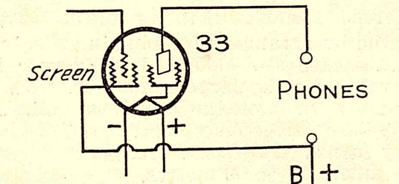
Sheet Metal, brass, copper, or aluminium, is made of a thickness corresponding to the wire gauge. Thus 18 gauge aluminium is equal in thickness to the diameter of an 18 gauge wire. Sheet-copper measures 4ft. by 2ft., and a sheet of tin-plate 20in. by 28in. Thin metal is cut with "snips," but thicker material should be cut with a hack-saw, for which the blades should have fairly fine teeth. The same style of blade may also be used for ebonite and similar material. Copper and brass may be obtained as thin as 36 gauge, as "copper foil" or "laten brass." Sheet-copper can be obtained tinned on one side. 24 to 28 are the usual gauges for shielding. For economy, sheet-iron may be used for panels and chassis.

Shielded Lead-In. Earth the shield through a variable resistance of 5000 ohms, and adjust the resistance according to the noise level—this also acts as a partial volume control.

Shielding. Copper and aluminium are the two correct metals for coil shielding. The higher the frequency, the thinner the metal required to produce an efficient shield. For best results a cylindrical shield should not be much less than double the diameter of the coil. It is important that all shielding should be continuous metal or in thorough contact throughout the length of all joints. These should be soldered, if possible, otherwise the efficiency of the shielding is impaired. For low-frequency shielding, such as on power-packs and mains filters, very thick metal is necessary to be really effective.

Short-Wave. Newcomers to short-wave reception should be particularly careful to consult call-books in order to ascertain at what time of day any particular station may be heard. A time converter to show local time compared with that at the transmitter—perhaps at the other side of the world—is also practically indispensable.

Short-Wave Audio. In the case of a short-wave set operated on 2-volt dry "A" batteries and having a 3-electrode output valve, it is a simple matter to obtain greater output volume by using a 33 pentode. This only entails replacing the four-pin socket with a five-pin, and connecting the extra screen connection to the B+ side of the phones, as shown in the diagram.



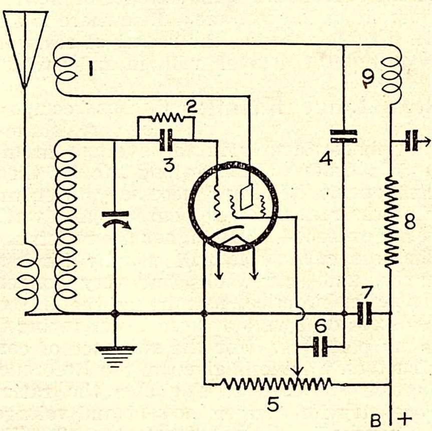
Short-Wave Audio

Short-Wave Troubles. When an ordinary regenerative short-wave receiver has been assembled, difficulty may be experienced in procuring oscillation. Some possible defects are here mentioned:—

1. Tickler may need reversing—a very common initial trouble. It may require more turns, if no oscillation, or if too violent, reduced turns.

2. Grid leak may be wrong value—too high gives high amplification with instability in the form of a high-pitched squeal—and sudden plop into oscillation—if too low, loss of amplification and difficulty in producing oscillation. Try connecting direct to earth instead of through coil.

3. Grid condenser usually .0001 mfd. to .00025 mfd. If oscillation comes with a sudden "plop," and if tickler turns have been adjusted, then increase value. Keep grid leads short and mount condenser as near grid as possible.



Short Wave Troubles

4. Fixed reaction condenser too small, or none used. Usual value .0001 mfd. to .00025 mfd.

5. Screen potentiometer may require more or less extra resistance in the lead to B+.

6. By-pass condenser on screen lead should be large, 1 to 2mfd.

7. Plate resistor value may not be right. From 100,000 to 200,000 ohms is usual when supply is about 250 volts.

8. R.f. choke may be too large—perhaps intended for broadcast. A 10 millihenry choke is ample for short-wave, as its self-capacity is low. No. 4 acts as a by-pass condenser to this choke, but often a small by-pass is connected on the B+ side also.

When using phones, if there seems to be much troublesome hand capacity (when handling the phones), place an r.f. choke in each output lead.

Skip Distance is a condition encountered in short-wave reception at no very great distance from the transmitter. Sometimes it has been found that signals from a powerful short-wave transmitter can scarcely be picked up at a distance of only a few miles from the station, while at a distance of 1000 miles or at the opposite side of the world, they are quite strong. For the purpose of explanation, we adopt the idea of a reflecting (Heaviside) layer in the sky at a height of many miles. Waves proceeding in all clear directions from the station cannot bend with the curvature of the earth, but proceed in a straight line until they strike the "layer," when they are reflected at the opposite equal angle, and by several reflections in this way, reach the opposite side of the earth. At the first stage the absence of the wave while its route is close to the layer is more pronounced than at later stages, where reflections have caused more diffusion, and where also waves may reach by other routes, thus giving a better average field strength. New Zealand reception of the Australian short-wave stations appears to be at times affected by this "skip" effect, giving erratic reception. "Skip" changes with frequency of transmission, and also seasonally, being more noticeable at night than by day, and greater in winter than summer. At the outer edge of the skip distance there may be periods of distortion and severe fading. At high frequencies the ground-wave is lost after travelling a comparatively short distance.

Sky-Wave. This is the same as the ground wave, except that it is the portion of the transmitted signal that takes an upward angle. If it travelled upwards in a straight line indefinitely, it would be lost, but it is reflected by the Heaviside layer, and travels round the world by means of several deflections of the straight line, much in the same way as an octagonal figure approximates to a circle, with each corner to represent a point of reflection.

"Soft" Valves Sometimes a power-valve that has been in use for some time will show a blue glow when working—a sure sign that it requires replacement, having gone "soft," which is a term used to indicate that stray gases have found their way into the vacuum from the metal electrodes, and when ionised by the current, show a blue glow. The excepton to this rule is the power pentode, which normally shows a blue glow when working, owing to electrons striking the interior surface of the glass bulb.

Soldering is easily learnt with a small amount of practice, and is very necessary in joining wires for radio work. An electric soldering-iron consuming 60 watts will answer well, the larger size consuming 100 watts. A small "copper bit" to be heated on a gas stove or fire may be used. The main thing is to keep the point of the iron clean and well "tinned" with solder—an occasional scrape with an old pocket-knife helps matters. A black point will not transfer heat to the work. For the initial tinning heat the iron, rub the point on glass-paper to clean it, then apply resin-cored solder, which will spread over the tip, assisted perhaps by rubbing the point with a piece of thick wire. Clean with glass-paper or by scraping with a knife any metal to be joined. If the separate parts are first separately "tinned" with solder, they will easily join when held together and the iron pressed on them. A small amount of solder makes a neat joint. Excess may be wiped off with a rag before it sets. Do not let a joint move while the solder is setting, or it may form a brittle connection. For heavy work such as joining copper shielding, etc., it is a good plan to use ordinary solder and "killed acid" flux, which is made by dissolving pieces of zinc in a saucer with spirits of salts (commercial hydrochloric acid) from the chemist. In an hour or so, when all effervescence has ceased, the liquid is poured into a bottle and kept for use; apply with a pointed stick. A satisfactory method of soldering aluminium has not yet appeared.

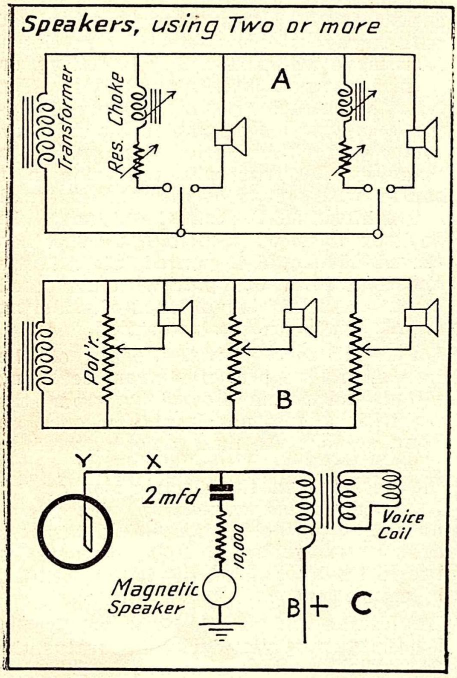
For satisfactory use, the tip of the iron should be prevented from becoming pitted, and this is effected by wiping the tip with a rag not less than once an hour, so that the flux is not allowed to remain in the iron too long. It is a good idea not to run the electric iron at full heat after it has warmed up. If a resistance of 10 to 30 ohms is switched in series after warming up, it will lengthen the life of the iron. Find the best resistance by experiment.

A candle and mouth blowpipe gives a handy temporary soldering apparatus, the flame being directed upon the joint, no iron being necessary.

Soldering a lead to an earth pipe is facilitated by sawing a V notch in top of pipe with a hacksaw; tin the notch and solder the wire into it. A blow-lamp of some kind is necessary, because an iron will not supply sufficient heat.

Speakers, Using Two. When two identical dynamic speakers are connected in parallel to an output transformer, then when one speaker is disconnected, there is an increase in volume of about 40 per cent. from the remaining speaker if no means of compensation is provided. There will also be a difference of quality of reproduction, because the speaker impedance is double when only one is working. To compensate for these differences it is necessary, when one speaker is switched off, to connect in its place an equivalent impedance—the best form is a copy of the moving coil over an iron case. As a rule, a simpler expedient will be required, such as a non-inductive resistance of suitable value. However, this weakens the high notes. Another method (a) is to place in series with a variable resistance an audio choke with moveable laminated core for adjustment to preserve high notes. The choke value must be high, and the resistance low. Several speakers may be connected in the same way.

Another method (b) is to connect potentiometers across the output, as shown in the diagram, which allows the volume of each speaker to be regulated independently. The resistance of the potentiometer should not exceed 400 ohms for dynamics.


Speakers, using Two or more

There is no theoretically correct way of working a magnetic and dynamic speaker from the same output, but the best method of compromise is shown in diagram C. Different values of resistance should be tried in place of the 10,000 ohms resistor shown. A variation is to move the 2 mfd. condenser to X and feed "B+" to the plate through an audio choke at Y, so that no "B" current will traverse the primary of the output transformer, of which one side will be earthed.

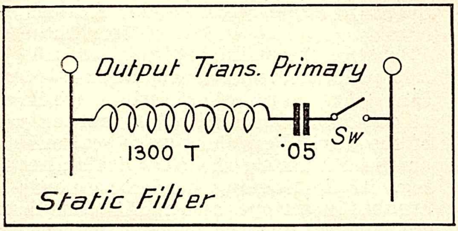
Speaker Position. The position of the loud-speaker in a room should be found by trial, so that the best possible may be permanently adopted. No particular rule can be laid down, because the size and shape of rooms vary so widely. In one corner at the opposite end to the listeners is often satisfactory, but the speaker should not be too close to the wall in any position. The speaker should be about level with the listeners' ears, but is better too high up than too low.

Speaker Rattle is very quickly noticed, but actually the noise may not be the fault of the speaker adjustment at all. An overloaded output valve can produce a rattling noise that usually throws suspicion on the speaker. Possibly the valve may be nearing the end of its life, and require renewing.

Speaker Reproduction should theoretically be from 32 to 9000 cycles, but actually a much shorter range than this will give apparently good reproduction. A good output stage and dynamic speaker giving a response from 40 to 6000 cycles will be classed as extremely good quality while from a magnetic cone speaker the range might only be from 150 to 5000 cycles, and yet be classed as good by the uninitiated. Experimenters who have spent time developing amplifiers to give the widest possible range of reproduction know what to listen for in the output. Deep notes always add body to reproduction, and high notes brilliance, but a slight cut-off of high notes is rather an advantage in the case of a receiver situated a long distance from the nearest station. Gramophone records cut off at 5000 cycles.

Static is nobody's friend, and it has often proved a great hindrance to commercial radio. Leading engineers have experimented for years with eliminators, mostly on the balancing-out principle, now declared useless. At the best the cure is only partial, owing to the complex nature of static. All that the amateur experimenter can do is to reduce its intensity by various subterfuges. One of these is to place across the speaker a variable high resistance, say 25,000 or 50,000 ohms in series with a ½ or ¼ mfd. condenser. When the resistance is cut out, highest notes and static will be practically eliminated. Speech will be clearly readable, although music will be deepened in general tone. Loose coupling between the aerial and grid coil will weaken static to a greater extent than the signal, but this only refers to the aerial stage, and not to subsequent r.f. stages. Incidentally, loose coupling also tends to weaken power-line interference entering via the aerial. Many listeners imagine they are receiving static when it is really local power interference, of which a great deal more usually enters by the aerial than by the power-lines connected to an a.c. set. Sharp tuning helps to weaken static, as also does an aerial near the ground—two or three feet above. Some static is of an oscillatory character, and gives different effects on different wavelengths. Static centres can be located by direction finding methods. Selective receivers and directional aerials, such as the Beverage, form the best means of reducing static. A six-mile long Beverage is used on trans-Atlantic longwave telephony.

Static Filter. A very effective filter to cut down static and all high audio frequency scratch and hiss is made by winding upon an empty sewing-cotton reel with about three-quarter-inch centre, 1300 turns of 36 enamelled wire.



Place this choke in series with a .05 mfd. fixed condenser and connect across the primary of the output transformer with an on-off switch. When background noise is bad, switch in the filter, and reception will be much more agreeable. A larger condenser will give a lower cut-off. The switch can be arranged to give choice of two or more capacities.

Super-Control in the newest valves is obtained by using a non-uniform construction in the spacing of grid and screen meshes. At low negative bias, the non-uniform spacing has the same effect upon the plate current as if uniform, but as the bias is made more negative, the current from those areas of the cathode covered by the closely-wound grid turns is gradually cut off, rendering that portion of the cathode ineffective. At the same time the plate current and mutual conductance characteristics change to minimise the factors responsible for cross-modulation and modulation distortion.

Superheterodynes continue to increase in popularity on account of their selectivity, which enables them to separate stations 10 k.c. apart. On short-waves they also have the much-needed sharpness of tuning so necessary to avoid interference from powerful morse stations. Constructors are now able to purchase intermediate frequency transformers ready-made and tuned to a given frequency. Care is required in the selection of the intermediate frequency for an all-wave superhet, because the nearer the i.f. to the frequency on which signals are being received, the greater the efficiency. On the other hand, the lower the i.f., the greater the amplification. Thus it has been found best for all-wave receivers to fix the i.f. just above the broadcast band, so that 460 or 472.5 k.c. may be used. The plate and grid coils are of the honeycomb type, each tuned by a pre-set variable condenser, or better still, a midget air dielectric type, one being enclosed in each end of the coil can. The advantage of the latter type is non-variation due to temperature and humidity changes, and these can be greater than is usually suspected.

The advent of the 2A7 type of valve has assisted the idea of combining first detector (or mixer) and oscillator in one valve, and for the second detector the 2B7 type is now available, combining diode detector, pentode, audio or r.f. amplifier, and automatic volume control. With this arrangement it is possible to precede the mixer by one r.f. stage, employing a total of five valves (excluding rectifier), with one i.f. stage. Using a 55 type, the same conditions prevail, except that the amplifier section is a triode (56).

A superhet is more satisfactory with an r.f. stage preceding the mixer, because "second channel" interference is thereby much reduced.

For short-wave reception a separate oscillator has its advantages.

Terrain is the "ground" between transmitter and receiver, and has a great influence upon strength and quality of recepton. Sea-water is the best terrain followed by flat marshy land, pastoral country, wooded flat country, bush or mountainous country, and worst of all very broken, mountainous country covered with bush.

Testing—80. For testing purposes, when an 80 or similar rectifier is in use, pull out the valve and reinsert only the two filament prongs, the two plate prongs being outside the socket. They may then be separately tested by prods on pin and socket, including a meter in the circuit. A touch in each socket will check each side of the transformer secondary.

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Threshold Howl occurs in some short-wave sets just as the receiver is going into oscillation. It is not only unpleasant, but limits signal reception, often preventing the set being operated at maximum sensitiveness. Stray r.f. in the audio circuit is usually the cause. Various precautions are: A by-pass condenser (.0003 mfd.) placed each side of the detector r.f. choke; an r.f. choke and by-pass condenser in any long speaker lead carrying plate current; a 100,000 carbon resistor in the grid lead to valve following detector. Too large a grid condenser and too low a value of grid leak may be causes.

Thyratron. A mercury vapour half-wave rectifier containing a grid, by which action may be controlled. With a very low voltage applied to the plate, very little current passes, and this condition holds up to about 15 volts, when at a certain critical point, heavy current will flow, without increase of voltage. The exact voltage is regulated so that the application of a negative impulse to the grid starts the flow of heavy plate current, the grid having no further control until the plate voltage drops. The thyratron has many uses, such as relay operation, converting d.c. to a.c., etc. A photo-cell may be used to produce the grid "trigger" action.

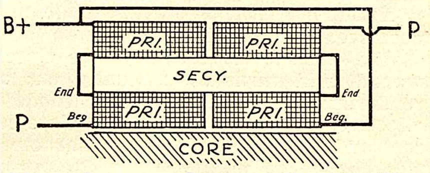
Tickler Coils are often a puzzle to the inexperienced constructor, and quite often a well-built receiver has refused to work simply because the tickler coil has been connected the reverse way round. Specifications give the average number of turns required, but very often this does not give the precise range of reaction required, owing to slight unavoidable differences in the circuit capacity and also in "B" voltage, so that it can happen that a newly-built receiver will not oscillate until two or three or more tickler turns have been added.

If reaction is too fierce and the set will not stop oscillating, turns must be taken off. The best way of adjusting the tickler is to tune in the top or highest wavelength on the band, and so adjust tickler turns and, if necessary, plate voltage, that the set will just oscillate when the reaction condenser or resistance is full in.

Resistance is not of importance in the reaction circuit, because there is plenty of energy, so that tickler coils are best wound with fine wire, 36 gauge or smaller, because heavy wire has more effect upon tuning adjustment with changes of reaction coupling.

Time Factor. This is an important factor in short-wave listening, the first point to remember being that the other half of the world is observing night when we are enjoying daylight hours, and in Europe it is midnight or thereabouts when it is the middle of the day with us. On account of this fact the chief stations received here during the daytime, from Europe are the colonial transmissions sent out at times specially suited to remote parts of the world. A receiver with several valves will pick up American short-wave stations from noon until 4.30 p.m., which is midnight, Eastern Standard Time. The earlier stations received are on 25 and 31 metres, those on 49 metres becoming readable at 2.30 to 3.30 p.m., according to conditions. Mexican, Spanish and other stations are heard at various times during the earlier part of the day. Few short-wave stations are on the air during the New Zealand evening. Early morning here corresponds to evening in Europe, and at this time many stations may be heard. Just before daylight a number of high-powered European stations may be heard on the broadcast band, particularly if the receiver is well located. The enthusiast will use a DX Time Indicator, which greatly assists the search for stations.

Transformers—Output. An output transformer is employed firstly so that the plate current of the last valve does not pass through the (magnetic) speaker windings, and secondly, as a ready means of matching the speaker impedance to that of the output valve or push-pull pair. The matching is accomplished by means of "ratio" turns on the secondary winding. A push-pull transformer has a centre-tap in the primary winding, half the plate current flowing through each side, while for a single valve a straight single winding is provided. The secondary winding is single in either case, and for 1 to 1 ratio its turns equal those on the total primary, while for higher ratios the secondary turns are determined by dividing the total primary turns by the required ratio. Thus, with 3000 primary turns for 2-1 ratio, the secondary would require 1500 turns, and for 30-1, only 100 turns. For the primary winding, 36 gauge wire will generally be suitable, and the same for low ratio secondaries, while above 10-1 the gauge for the secondary may be increased to 32, increasing the gauge as the ratio rises, with 26 at 30-1 and 24 or 22 at 60-1, according to the watts carried. The trans-



Transformer—Output (Push-pull)

former secondary should theoretically have a lower d.c. resistance than the speaker voice coil, but in practice this would tend to make the secondary winding too bulky, so a reasonable compromise is arrived at.

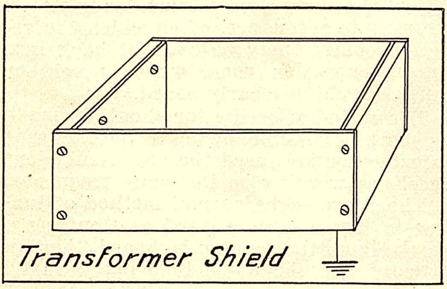
A good single output transformer is made with a 1in. stalloy core as used for power transformers, with "window" 1½in. long. Half the primary winding is put on, then the secondary, followed by the remainder of the primary, all layer wound and well insulated. Total primary turns will be 2400, 36 gauge enamelled wire. Secondary turns calculated as above, with taps to give several ratios.

For push-pull, first put on two halves of the primary of 2400 turns each, then the secondary, and two further primary halves of 2400 turns each. The primaries are connected, beginning at first inside winding to end of outside winding on opposite side, and also to "B+"; finish of first inside winding to beginning of outside on same side; end of this outside to plate. Beginning of second inside winding to plate, end to beginning of outside winding on same side.

A 1¼in. core for push-pull requires a total of 3200 turns of 34 gauge wire, divided as above, into 4 sections of 800 turns each. Only high ratios for dynamic speakers will be required, so 24 gauge wire may be used. For 20-1 160 turns; 29 to 1, 110 turns; and so on. For an output from 6 to 10 watts, use 22 gauge wire instead of 24. Window 2⅝in. x ⅝in.

All the above windings are supposed to be in the same direction.

Transformer Shield. An easily-made and effective metal container for a home-built power transformer is constructed as shown in the diagram, wooden ends ⅜in. thick being placed outside the metal, so that all sections are screwed to the wood. Cut the six pieces of metal separately each to the exact size required, and drill holes for screws. Attach the two metal ends to the inside of the wood ends, then screw on the bottom and two sides, and finally the cover, when the transformer is in place, with well insulated leads coming through holes in the wooden ends, the holes in the metal being drilled slightly larger. Open joints along the edges will serve for ventilation.

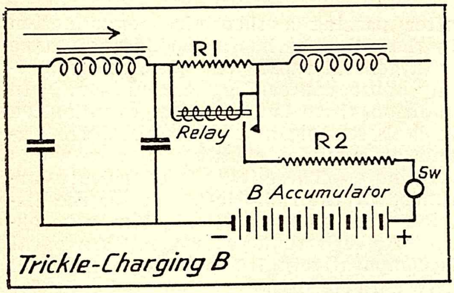


Transformer Shield

Transmitting is a hobby to which many radio listeners are eventually attracted. A license to transmit is issued to an amateur only after passing a theoretical examination to show that he has a good acquaintance with general radio principles, and especially those concerning transmission. In addition, there is a practical examination in both sending and receiving Morse signals at a minimum rate of twelve words a minute. These examinations are arranged by the radio inspector for the district, from whom particulars may be obtained. A beginner's transmitting outfit is comparatively inexpensive, and will give a range of a few thousand miles at least. "Hams" generally build their own transmitters and thereby become highly proficient at constructive work, in addition to the radio experience of arranging an aerial system that will put signals over to the opposite side of the world. Having obtained a license, the tyro is free to operate on 80 metres with either key or 'phone, and at a later date on other bands. Good text-books for examination matter are "The Radio Amateur's Handbook" and Morecroft's work on the elements of radio transmission. (See "Code Practice.")

Trickle-Charging "B." This is a highly satisfactory system of trickle-charging a short-wave "B" accumulator with a small drain from a home-built broadcast power-pack, which in most houses is in use for several hours per day. During this time the accumulator is receiving a small charge that makes the "B" accumulator independent of a separate charger, while it is always in a well-charged state, and keeps in good order longer for that reason. The best idea is to make the whole system automatic, as shown in the diagram. The two power-pack chokes are shown. The relay may be 200 or 300 ohms, or other value, and the object of R1, 50 or 60 ohms, is to divert sufficient current through the relay to cause it to work. When the power-pack is operating, the relay closes, and "B" current flows through the accumulator, regulated by R2 to 10 milliamperes. The on-off switch is only for breaking the circuit if the short-wave set is used while the broadcast set is operating, but the accumulator is always connected to the short-wave set.

For non-automatic operation, simply omit the relay and R1 and connect R2 directly between the chokes. The object of the relay is to automatically prevent the accumulator discharging when not being charged, so its place must be taken by the on-off switch for non-automatic operation, that is, the switch must only be on when the broadcast set is operating. In case of the switch being accidentally left on, the drain would not be serious, as there would be in series R2 and the voltage-divider or higher resistances in the receiver. Values of R2 to give a 10 m.a. drain are given, the nominal voltage of the accumulator being around 112 volts. In actual practice the drain is small, because there is against it the limiting back-voltage of a well-charged accumulator.



Trickle-Charging B

Power-pack Voltage.	R2 Ohms.
350	20,000
300	15,000
250	10,000
200	6,000

The value of R1 is not critical, and must be kept low. It depends upon the resistance of the relay.

Tuning Range. When a new receiver has been constructed, there is often a doubt as to which is the correct dial setting at the high wavelengths so that the complete broadcast band is covered by the receivers. In the first place, the secondary coils must be capable of tuning up to 540 kilocycles with the condensers to be employed—175 microhenrys for .0005 mfd. and 250 mch. for .00035 mfd. Turn to the "Tuning Range" scale in the reference section, on which are show the corresponding metres and kilocycles against their average position on 100 and 180-degree dials. This shows that 2YA should come in at about 95 degrees on a 100-degree dial, or at 170 on a 180-degree dial. The only higher station is 2CO, about a degree above 2YA. Stations 3YA and 2BL will come in at approximately the positions shown, and if these are about right, the lower portion of the dial will look after itself, the position of 1500 k.c. depending to some extent upon the minimum capacity of the condensers and circuit combined.

The metres-kilocycles scale can also be used to read off equivalent values of one to the other, and if the "metre" side is read as "kilocycles," then the equivalent metres are shown on the kilocycle side, and vice-versa. For instance, 200 k.c. equals 1500 metres; 380 k.c. equals 790 metres.

Tuning Short-Wave. Listeners who have been used to broadcast tuning-in will find that the manipulation of short-wave dials requires rather different treatment. The art, however, is soon acquired, and the peculiarities of the particular receiver are soon mastered with a little practice. Short-wave receivers are mostly of the regenerative type, and consequently the handling of reaction plays an important part in reception. Firstly, all ticklers must have been adjusted so that the receiver passes into oscillation quite smoothly, with no violent squawks, and until this condition has been attained, searching for DX will be little more than wasted time.

With reaction at a minimum, only the "live" sound of the set is heard, but if the control is turned slowly, a point is reached when a quiet hissing is heard. Regeneration is now taking place, and the set is on the "threshold" of oscillation, the most sensitive condition. Turning the control slowly further, there will be a change in the rushing sound, varying somewhat with different receivers. The set is then oscillating, and when the detector dial is turned, a whistle will be heard as a station is encountered. If there is an r.f. stage the dial must be kept roughly in step with that of the detector, otherwise the station whistles may be too weak to hear. The detector dial may be stopped at a strong signal, and carefully adjusted for greatest volume, bringing r.f. stages into resonance, after which the reaction control may be brought back into the regeneration zone, when speech or music should be clearly heard.

The period of oscillation should be made as short as possible, owing to the fact that interference is caused thereby in adjacent receivers working on the same frequency.

The above is the normal method of tuning in, but if the wanted station has a weak signal that cannot be heard, then an attempt may be made to bring it in by

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"zero-beating." The reaction control is turned until the set is just oscillating, and by careful tuning it will be found possible to get exactly on the station frequency so that no whistle is heard unless the dial is turned slightly in either direction. In this position the oscillation frequency is exactly the same as that of the transmitting station, so that they cannot combine to produce a "heterodyne" whistle, which is only a product of difference in frequency. Zero-beating does not always give the necessary clarity, but may prove the only means of identifying a station.

Type 83 Rectifier. A flash-over at starting sometimes occurs due to a film of mercury condensing across the stem of this valve, thus giving a conductive path between the electrodes, which harmlessly burns away with a flash. This valve has long life if the 500 volts per plate and 250 m.a. drain is not exceeded.

Ultra-Short Waves below 10 metres have at present a limited range, because the rays are not reflected in space, so that a clear optical path must exist between transmitter and receiver. Using a wavelength of 18 centimetres (7 inches), telephony has been sent between Dover and Calais. Transmission on 7 metres is regularly sent out by 2ME, Sydney, but on this short wavelength is only likely to be received in New Zealand, during freak conditions. The tendency at present is to consider the band around 5 metres as suitable for purely local broadcast transmissions serving a radius of not more than perhaps 10 miles. Between Hawaiian Islands, communication is now kept up on telephony over as much as 200 miles, with transmitters and receivers up in the mountains and wired down to the regular service. Reception is clear and static-less.

Down to 4 metres, ordinary triodes can be used, but below that special valves are necessary, though much can be done with ordinary valves with bases removed.

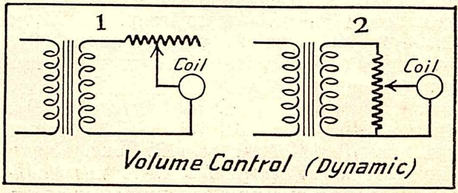
Valves of reliable manufacture undoubtedly give the best service. Purchasers of the "cheap" variety are quickly disillusioned of any ideas that they are "just as good" as those produced by reputable manufacturers. Not only is the "bootleg" valve liable to premature death, but only too frequently gives very indifferent service during its all too short span of life. "A fair price paid for reliable quality in all radio goods" should be the slogan of every constructor, if best results with minimum effort and worry are desired.

Valves in Parallel. Two similar output valves may be connected in parallel to carry double the undistorted volume of a single valve, but with still the same amplification as one. The two grids are connected together, as also are the plates and filaments. This is an economical method of increasing power output, if available from the earlier stages, because the only extra gear is the valve and socket. Any number of valves may be so connected.

Voltage Dividers should have a total resistance suited to the highest voltage applied, also remembering the amount of "bleed" current in constant drain that can be spared, which may suitably be from 8 to 12 m.a. Too small a "bleed" is liable to accentuate hum, and impairs regulation. A 400-volt supply with a divider of 25,000 ohms would bleed 16 m.a. and with 40,000 ohms 10 m.a.; a 250-volt supply with 25,000 ohms bleeds 10 m.a.; and with 15,000 ohms, 16 m.a. A small power-pack rated to deliver 30 or 40 m.a. should not be bled more than 5 or 6 m.a., otherwise the total voltage may be lowered, hum produced, and quality affected. The voltage actually delivered at each tap is reckoned separately, taking into account that after each valve has drawn its quota of plate current, there is less current flowing in the remainder of the divider, although the "bleed" is constant throughout.

Voltage Drop. A table in the Reference Section will be found useful in ascertaining the volts dropped by a resistance, or the value of a resistance to give a certain voltage drop. It is not the total voltage so much as the voltage lost or dropped, which usually concerns us. Say we have a supply at 250 volts and wish to reduce it in part of the circuit to 200 volts; 50 volts must be dropped, and with 4 m.a. passing, we look against this and under 50 volts in the table, which shows the required resistance to be 12,500 ohms. Or suppose we have a choke of 500 ohms resistance, to pass 30 m.a. Opposite 30 we find 500 ohms, which shows that 15 volts will be dropped, so an initial 200 volts is reduced to 185 volts. The method of actually calculating these values is shown under the heading "Calculations."

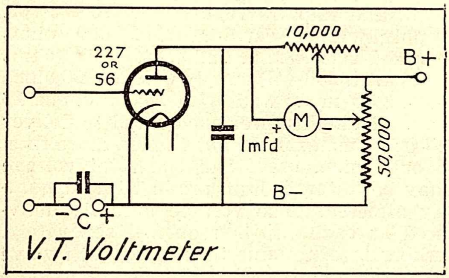
Volume Control may be connected across the voice coil of a dynamic speaker in two ways as shown. The value of the potentiometer in No. 2 will be quite low, but is best determined by trial. In both cases the re-



Volume Control (Dynamic)

sistance total depends upon the impedance of the voice coil. This type of control is useful when it is desired to reduce volume while using the telephone. A switch may be placed to put the resistance, preset to the required reduction, across the voice coil leads.

V.T. Voltmeter. The vacuum-tube voltmeter is a simple instrument that has a wide range of uses. Its operation depends upon the fact that a milliammeter in the plate circuit of a valve indicates change of plate current for a definite value of applied a.c. voltage. The scale of the meter determines the range. The grid must be kept negative. Infinitesimal power is required for operation, and in conjunction with an oscillator, the matching of coils is accurately accomplished. Bias is best suplied by a C battery as shown, about 12 volts negative bias being required with 100 volts "B."



V.T. Voltmeter

Watt. A watt is the electrical power in a circuit with one ampere passing at a potential of one volt. A kilowatt is 1000 watts. A watt may be .1 amp. at 10 volts, 2 amps at ½ volt, and so on, watts being ascertained by multiplying volts by amps. At 230 volts a 28 gauge wire will carry 46 watts, but at 115 volts only 23 watts will be carried, because .2 amp is the current-carrying capacity of the wire.

The watt-hour and kilowatt-hour represent not power but energy, or work done by electric current in a given time. Electricity is sold by the kilowatt-hour, which is one unit of electricity. The amount of current consumed (amperes) determines how long a unit will work; that is to say, a kilowatt-hour is either 1000 watts for 1 hour, 1 watt for 1000 hours, or some rate of consumption between the two. For instance, take a 60-watt lamp. Dividing 60 into 1000 (watts) we get about 16½, which is the number of hours the lamp runs on one unit.

An electricity meter has several dials, and running from left to right, each one reads one-tenth of the previous one. Near the right is one marked "1 k.w.h. per division," showing one unit consumed for every division registered, or 10 units for a complete revolution. Following this there may be another dial, each division being one-tenth of a unit, or one unit for a complete revolution. By running any piece of electrical apparatus alone, its consumption may be ascertained by timing the meter for say, half-an-hour. If in this time 30 watt-hours is shown, 60 watts per hour is the rate of consumption, which equals the consumption of the lamp mentioned above. The average radio receiver consumes from 50 to 100 watts, and a soldering-iron from 40 upwards. The cost per unit is ascertained by taking the last electric light account and dividing the nett charge by the number of units used.

Volts = watts divided by amps.
Amps = watts divided by volts.
Watts = volts multiplied by amps.

Wattage. Heat dissipated in resistances when a current flows is expressed in watts. This dissipation of heat is accompanied by a drop in voltage caused by the resistance. Voltage, current, and resistance all depend upon one another. The amperes passing are squared and multiplied by the resistance in ohms, giving the "watts dissipated." Thus, 40 m.a. (.04 amp.) squared equals .0016 amp., multiplied by 82 ohms, equals .13 watts dissipated. Resistances must be chosen to carry the required current without overheating, because watts dissipated represent lost energy. The ordinary type of carbon high resistance is only supposed to carry 2 or 3 watts if long service is required, and the current should not exceed 6 or 8 m.a. If this type of resistor gets warm it is certainly carrying too much current and will soon break down.

"Westector" is a copper-oxide rectifier intended to take the place of the usual valve detector, particularly as the second detector of a superheterodyne. There are two types, for maximum inputs of 24 and 36 volts respectively. It can also be used as a full-wave detector, in which case the signal input value is doubled. At 1000 k.c. the load resistance is 10,000 ohms. The action of the rectifier is equal to that of a diode detector, and for A.V.C. the full-wave gives results equal to a duo-diode valve. As in a diode, there is no amplification.

Wire. For current-carrying comparison the cross-section area is useful. Sometimes this is given in "circular mils," which is a dimension arrived at by squaring the diameter, but this is actually much greater than the real diameter, though it may be used for comparison when all items are given in the same term. The cross-sectional areas given in the table at the end of the book are the actual areas, and not circular mils.

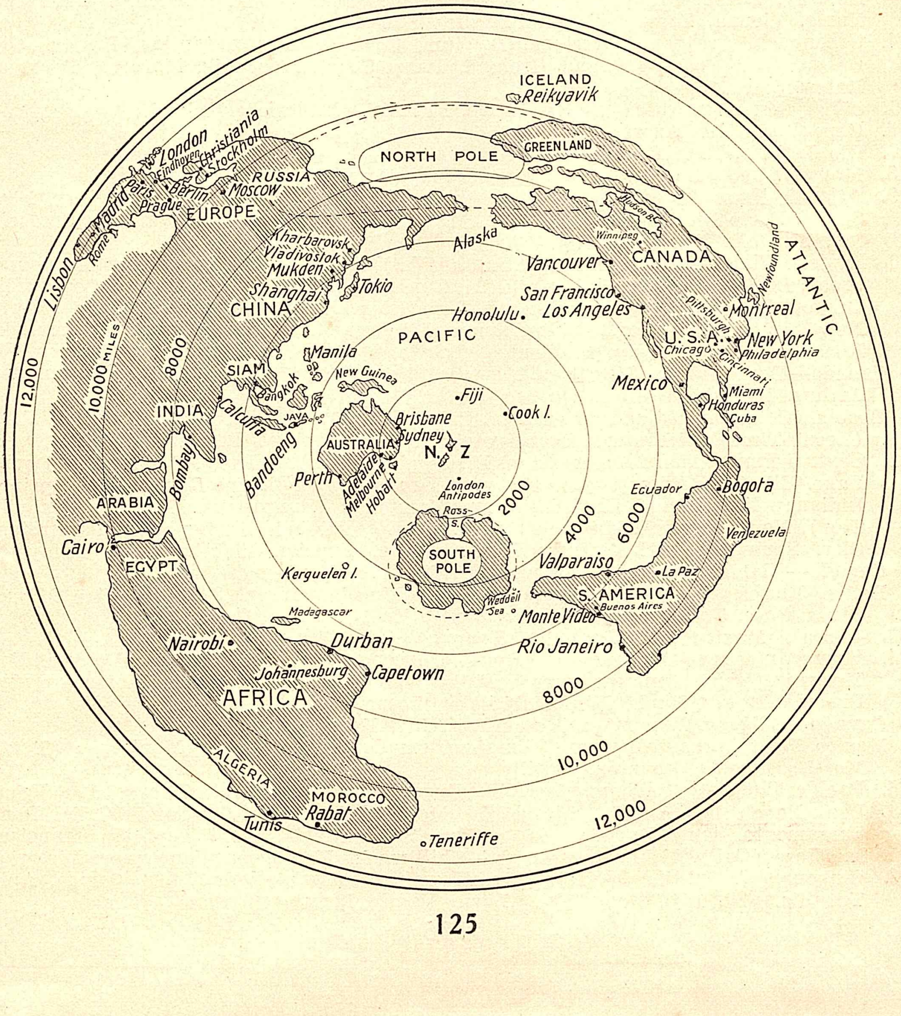
Section 6.

REFERENCE CHARTS AND TABLES

WORLD DISTANCES

ORDINARY maps are of little use for ascertaining distances of thousands of miles, and so the special map shown below has been prepared to enable dxers to measure approximate distances from New Zealand to any part of the globe. Unfortunately this system of projection gives a very distorted outline to those countries far removed from the centre, but this does not detract from the value of the map when used for its intended purpose.

A Mercator's projection map can be used for showing directional bearings away from the poles, but for direction from, say, the Empire station, a "polar map" is necessary. On this, a straight line joining two points shows the radio path. Neither of these latter maps can be used to measure distances.



World Time Chart

TO use this chart, place a ruler across so that it shows New Zealand time at both sides; the time at all other places is then shown along the ruler.

Places on the left of Greenwich are "same day" until after (below) midnight N.Z., when they are "previous day." After midnight at the place in question it is again "same day."

Greenwich and all places to the right are "previous day" before midnight at the place in question; after (below) midnight they are "same day" until midnight N.Z., when they are again "previous day."

1. Brisbane, Corowa, British and German New Guinea, Melbourne, Newcastle, Queensland, Rockhampton, Tasmania.
2. Adelaide, Crystal Brook.
3. East Siberia, Khabarovsk, Korea, Japan (all), Nagaski, Gobe, Yokohama, Port Darwin, Dutch New Guinea.
4. Borneo, Canton (China), Hong Kong, Manila, Pekin, Perth, Shanghai.
5. Bandoeng, Malabar (Java), Indo-China, Saigon, Singapore, Sourabaya.
6. Bangkok, Burmah, Penang, Rangoon.
7. Calcutta, Tibet.
8. Central Siberia.
9. **Indian Standard Time**—Bombay, Ceylon, Delhi, Madras.
10. Afghanistan, Bakhara, East Russia, Mauritius, Persia.
11. Aden, Bagdad, British and German East Africa, Madagascar, Nairobi, Somaliland.
12. Bucharest, Cairo, Capetown, Constantinople, Durban, Finland, Egypt, Greece, Johannesburg, Lapland, Leningrad, Moscow, Odessa, Rhodesia, Syria, Union of South Africa, German S.W. Africa.
13. Belgrade, Budapesth, Congo, Denmark, Germany, Italy, Motala (Sweden), Nauen, Norway, Posen, Prague (Podebrady), Rome, Skamleback, Sweden, Switzerland, Tunis, Vienna, Zeesen, Zurich (English Summer Time),
14. **Greenwich,** Arajuez, Barcelona, Belgium, Chelmsford, Constantine, France, Gibraltar, Gold Coast, Holland, Ireland, Ivory Coast, Kootwijk, Morocco, Portugal, Rabat, Spain.
15. Canary Is. (Teneriffe), Sierra Leone, Funchal (Maderia), Iceland.
16. Cape Verde Is., Azores.
17. Rio Janeiro, East Brazil.
18. Monte Video (Local), Uruguay, Paraguay, Newfoundland.
19. **Atlantic Time**—Argentine, British Guiana, Bolivia, Buenos Aires, Halifax, Nova Scotia, Porto Rico, West Brazil, West Indies, E. Labrador, P. Edward Is. Frederickton, St. John, Monckton.
20. **Eastern Time**—Albany, Akron, Atlanta (Va.), Augusta, Baltimore, Boston, Boundbrook, Buffalo, Canton, Charleston (2), Cincinnati, Cleveland, Columbus, Coytesville, Dayton, Detroit, Harrisburg, Kearny, Long Island, Mansfield, Mason, Miami (Flor.), New Jersey, New York, Philadelphia, Pittsburg, Portland, Richmond, Roanoke, Rochester, Schenectady, Talimadge, Toledo, Utica, Washington, Youngstown.
    Canada—Bowmanville, Hamilton, Montreal, North Bay, London (Ont.), Ottawa, Port Arthur, Prescott, Preston, Quebec, Waterloo.
    Bogota (Columbia), Santiago (Chile), Cuba, Ecuador, Haiti, Havana, Jamaica, Peru.
21. (Local Time) Micaragua, Tegucigalpa, Honduras, Costa Rica, San Jase.
22. **Central Time**—Amarillo, Anniston, Birmingham (Al.), Chicago, Des Moines, Devil's Lake, Elk City, Fort Wayne, Gadsden, Grand Forks, Grand Rapids, Hot Springs, Indianapolis, Kansas City, Madison, Memphis, Minneapolis, Mobile, Nashville Tex.), New Orleans, Oklahoma City, Omaha, St. Joseph, St. Louis, St. Paul, Sioux City, Springfield (Ill.), Terre Haute, Tulsa, Tupeka, Vicksburg, W. Lafayette.
    Canada—Alameda, Brandon, Kingston, Winnipeg, Yorkston (Gal.).
    Belize, Flores, Guatamala, Jalapa, Liberia, Merida, Oxaca, Salvador, San Miguel, Santa Rosa, Tampico, Vera Cruz, Mexico E., Honduras, Costa Rica, Heredia.
23. (Local) Mexico City, Acapulco, Tampico.
24. **Mountain Time**—Albuquerque, Butte, Cheyenne, Colorado Springs, Denver, Fort Morgan, Grand Junction, Great Falls, Gunnison, Helena, New Mexico, Ogden, Phoenix, Raton, Rapid City, Wolf Point, Yuma (Cal.).
    Canada—Calgary, Edmonton, Moose Jaw, Red Deer, Regina.
    Mexico West, Aguascalientes, Chihuahua, Guadalajara, Linares, Monterrey (Mex.), Morelia, Pueblo, Reynosa, Saltillo.
25. **Pacific Time**—Bellingham, Cervallis, Eugene, Eureka, Everett, Fresno, Las Vegas, Long Beach, Los Angeles, Marshfield, Medford, Pasadena, Portland (Cal.), Reno, Sacramento, Santa Barbara, Santa Cruz, Santa Maria, San Diego, San Francisco, San Jose (Cal.), Yokima. Canada—Chilliwack, Kamloops, Vancouver, Victoria.
26. Yukon. **27.** Tahiti. **28.** Honolulu, Hawaii (Sandwich Isds.). **29.** Samoa, Apia, Tutuilla. **30.** Fiji, Suva (Viti Levu, Vanua Levu), Chatham Islands.

N.Z. Time	SYDNEY 1	ADELAIDE 2	JAPAN 3	PERTH 4	INDO-CHINA 5	BANGKOK 6	CALCUTTA 7	CENT. SIBERIA 8	INDIAN ST. TIME 9	PERSIA 10	ADEN 11	CAPETOWN 12	ROME 13	GREENWICH 14	ICELAND 15	AZORES 16	RIO JANEIRO 17	MONTE VIDEO 18	ATLANTIC 19	EASTERN 20	NICARAGUA 21	CENTRAL 22	MEXICO 23	MOUNTAIN 24	PACIFIC 25	YUKON 26	TAHITI 27	HONOLULU 28	SAMOA 29	INT. DATE LINE FIJI 30	N.Z. Time
NOON XII																															NOON XII
	11		10	9	8		7		6	5	4	3	2	1	12	11	10		9	8		7		6	5	4	3			1	
I		11				8		7										10			8		7					3	2		I
	12		11	10	9		8		7	6	5	4	3	2	1	12	11		10	9		8		7	6	5	4			2	
II		12				9		8										11			9		8					4	3		II
	1		12	11	10		9		8	7	6	5	4	3	2	1	12		11	10		9		8	7	6	5			3	
III		1				10		9										12			10		9					5	4		III
	2		1	12	11		10		9	8	7	6	5	4	3	2	1		12	11		10		9	8	7	6			4	
IIII		2				11		10										1			11		10					6	5		IIII
	3		2	1	12		11		10	9	8	7	6	5	4	3	2		1	12		11		10	9	8	7			5	
V		3				12		11										2			12		11					7	6		V
	4		3	2	1		12		11	10	9	8	7	6	5	4	3		2	1		12		11	10	9	8			6	
VI		4				1		12										3			1		12					8	7		VI
	5		4	3	2		1		12	11	10	9	8	7	6	5	4		3	2		1		12	11	10	9			7	
VII		5				2		1										4			2		1					9	8		VII
	6		5	4	3		2		1	12	11	10	9	8	7	6	5		4	3		2		1	12	11	10			8	
VIII		6				3		2										5			3		2					10	9		VIII
	7		6	5	4		3		2	1	12	11	10	9	8	7	6		5	4		3		2	1	12	11			9	
IX		7				4		3										6			4		3					11	10		IX
	8		7	6	5		4		3	2	1	12	11	10	9	8	7		6	5		4		3	2	1	12			10	
X		8				5		4										7			5		4					12	11		X
	9		8	7	6		5		4	3	2	1	12	11	10	9	8		7	6		5		4	3	2	1			11	
XI		9				6		5										8			6		5					1	12		XI
	10		9	8	7		6		5	4	3	2	1	12	11	10	9		8	7		6		5	4	3	2			12	
MID XII NIGHT		10				7		6										9			7		6					2	1		MID XII NIGHT
	11		10	9	8		7		6	5	4	3	2	1	12	11	10		9	8		7		6	5	4	3			1	
I		11				8		7										10			8		7					3	2		I
	12		11	10	9		8		7	6	5	4	3	2	1	12	11		10	9		8		7	6	5	4			2	
II		12				9		8										11			9		8					4	3		II
	1		12	11	10		9		8	7	6	5	4	3	2	1	12		11	10		9		8	7	6	5			3	
III		1				10		9										12			10		9					5	4		III
	2		1	12	11		10		9	8	7	6	5	4	3	2	1		12	11		10		9	8	7	6			4	
IIII		2				11		10										1			11		10					6	5		IIII
	3		2	1	12		11		10	9	8	7	6	5	4	3	2		1	12		11		10	9	8	7			5	
V		3				12		11										2			12		11					7	6		V
	4		3	2	1		12		11	10	9	8	7	6	5	4	3		2	1		12		11	10	9	8			6	
VI		4				1		12										3			1		12					8	7		VI
	5		4	3	2		1		12	11	10	9	8	7	6	5	4		3	2		1		12	11	10	9			7	
VII		5				2		1										4			2		1					9	8		VII
	6		5	4	3		2		1	12	11	10	9	8	7	6	5		4	3		2		1	12	11	10			8	
VIII		6				3		2										5			3		2					10	9		VIII
	7		6	5	4		3		2	1	12	11	10	9	8	7	6		5	4		3		2	1	12	11			9	
IX		7				4		3										6			4		3					11	10		IX
	8		7	6	5		4		3	2	1	12	11	10	9	8	7		6	5		4		3	2	1	12			10	
X		8				5		4										7			5		4					12	11		X
	9		8	7	6		5		4	3	2	1	12	11	10	9	8		7	6		5		4	3	2	1			11	
XI		9				6		5										8			6		5					1	12		XI
	10		9	8	7		6		5	4	3	2	1	12	11	10	9		8	7		6		5	4	3	2			12	
NOON XII		10				7		6										9			7		6					2	1		NOON XII

Same Day

Previous Day

Same Day Fiji only

Same Day

Previous Day

Same Day Fiji only

Voltage Drop across Resistances

Milli-amperes	VOLTS DROPPED																
	10v.	15v.	20v.	25v.	30v.	35v.	40v	50v.	60v.	80v.	100v.	120v.	140v.	160v.	180v.	250v.	300v.	350v.
	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS
2	5000	7500	10,000	12,500	15,000	17,500	20,000	25,000	30,000	40,000	50,000	60,000	70,000	80,000	90,000	120,000	150,000	175,000
4	2500	3750	5000	6250	7500	8750	10,000	12500	15000	20,000	25,000	30,000	35,000	40,000	45,000	62,500	75,000	87,500
6	1666	2500	3333	4166	5000	5833	6666	8333	10,000	13,333	16,666	20,000	23,333	26,666	30000	41,666	50,000	58,330
8	1250	1875	2500	3125	3750	4375	5000	6250	7500	10,000	12500	15,000	17500	20,000	22500	31,250	37,500	43,750
10	1000	1500	2000	2500	3000	3500	4000	5000	6000	8000	10,000	12000	14,000	16,000	18,000	25,000	30,000	35,000
12	833	1250	1666	2083	2500	2916	3333	4166	5000	6600	8333	10,000	11,600	13,333	15,000	20,830	25,000	29,160
14	714	1071	1428	1785	2142	2500	2857	3571	4300	5700	7000	8500	10,000	11,400	12850	17,850	21,420	25,000
16	625	937	1250	1562	1875	2187	2500	3125	3750	5000	6250	7500	8750	10,000	11,250	15,620	18,750	21,870
20	500	750	1000	1250	1500	1750	2000	2500	3000	4000	5000	6000	7000	8000	9000	12,500	15,000	17,500
25	400	600	800	1000	1200	1400	1600	2000	2400	3200	4000	4800	5600	6400	7200	10,000	12,000	14,000
30	333	500	666	833	1000	1166	1333	1666	2000	2606	3333	4000	4666	5333	6000	8330	10,000	11660
35	285	428	571	714	857	1000	1142	1428	1714	2285	2857	3428	4000	4571	5142	7140	8570	10,000
40	250	375	500	625	750	875	1000	1250	1500	2000	2500	3000	3500	4000	4500	6250	7500	8750
50	200	300	400	500	600	700	800	1000	1200	1600	2000	2400	2800	3200	3600	5000	6000	7000
60	166	250	333	416	500	583	666	833	1000	1333	1666	2000	2333	2666	3000	4160	5000	5830
70	142	214	286	357	428	500	573	715	857	1142	1430	1720	2000	2270	2570	3571	4285	5000
80	125	187	250	313	375	437	500	626	750	1000	1250	1500	1750	2000	2240	3130	3760	4380
100	100	150	200	250	300	350	400	500	600	800	1000	1200	1400	1600	1800	2500	3000	3500
125	80	120	160	200	240	280	320	400	480	640	800	960	1120	1280	1440	2000	2400	2800
150	67	100	135	133	200	233	266	333	400	533	666	800	933	1000	1200	1666	2000	2333

See "Facts" Section

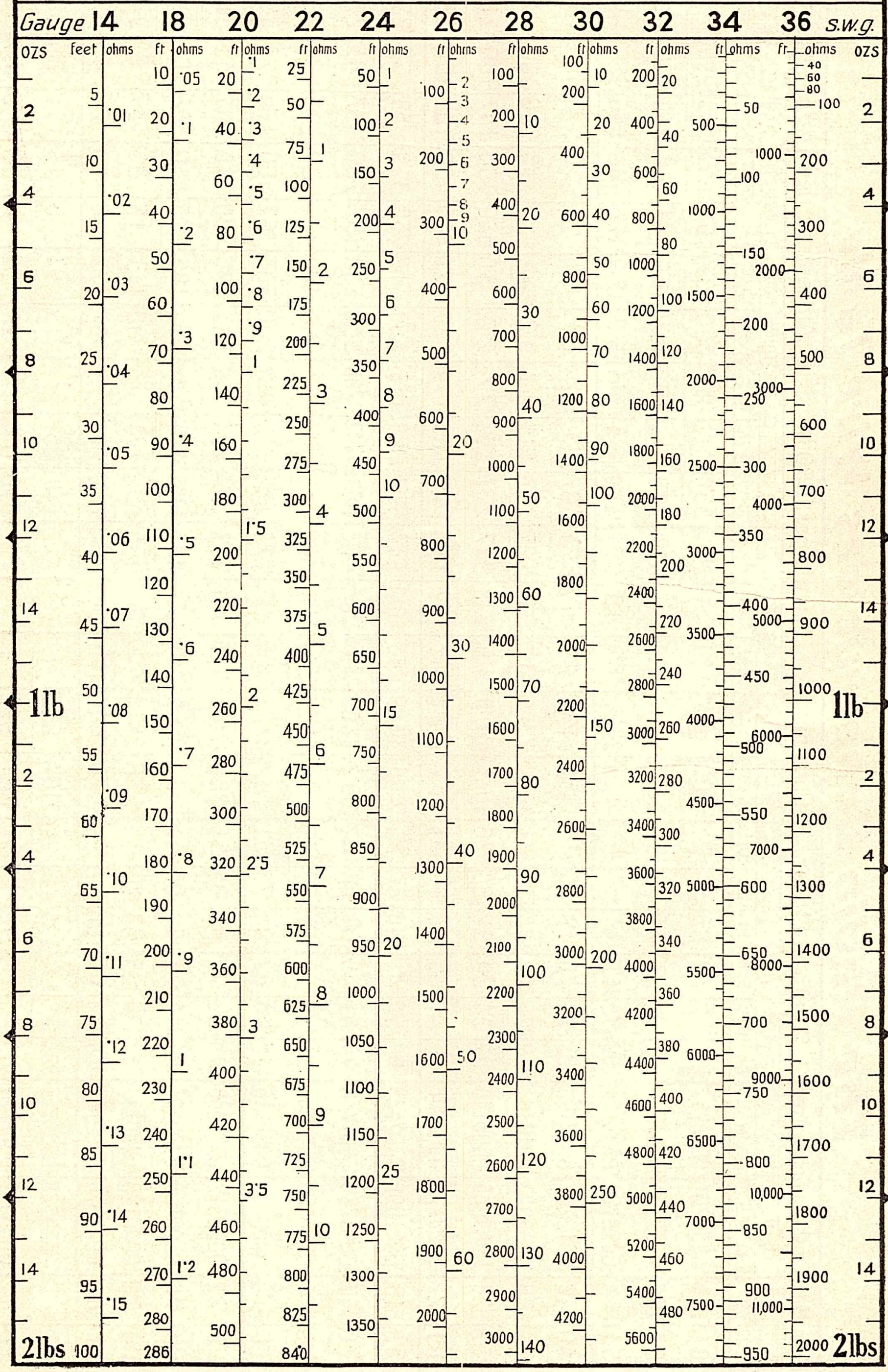
Output Ratios for Dynamic Speakers

Any Valve Arrangement

Total Output Valve Load Resistance	*Speaker Impedance (ohms)*																		
	1	2	3	4	4·5	5	5·5	6	6·5	7	7·5	10	12	15	20	25	30	40	50
500	22·4	15·9	13·0	11·2	10·6	10·0	9·56	9·1	8·7	8·4	8·1	7	6·4	5·7	5	4·4	4	3·5	3·1
1000	31·7	22·4	18·3	15·8	14·9	14·2	13·5	12·9	12·4	12·0	11·5	10	9·1	8·1	7	6·3	5·7	5	4·4
2000	44·8	31·7	25·9	22·4	21·1	20·0	19·1	18·0	17·6	17·0	16·3	14·1	12·8	11·5	10	8·9	8·1	7	6·3
3000	54·8	38·9	31·7	27·4	25·9	24·5	23·7	22·2	21·6	20·7	20	17·4	15·9	14·1	12·2	10·9	10	8·6	7·7
4000	63·3	44·8	36·6	31·7	29·9	28·3	27·0	26·0	24·9	22·9	23·1	20	18·3	16·3	14·1	12·6	11·5	10	8·9
5000	70·8	50·0	40·9	35·0	33·4	31·7	30·1	28·0	27·8	26·8	25·8	22·4	20·4	18·2	15·9	14·1	12·8	11·1	10
6000	77·5	54·8	44·8	38·7	36·9	34·3	33·0	31·0	30·4	29·3	28·3	24·5	22·4	20	17·4	15·5	14·1	12·2	10·9
7000	83·7	59·2	48·2	41·9	39·5	37·5	35·7	34·2	32·9	31·7	30·5	26·5	24·2	21·6	18·7	16·7	15·2	13·2	11·8
8000	89·5	63·3	51·7	44·8	42·2	40·0	38·2	36·6	35·2	33·8	32·7	28·3	25·8	23·1	20	17·9	16·3	14·1	12·6
9000	94·9	67·1	54·8	47·4	44·8	42·5	40·5	38·8	37·2	35·7	34·7	30	27·4	24·5	21·3	19	17·4	15	13·4
10,000	100	70·8	57·8	50·0	47·2	44·8	42·7	40·9	39·3	37·9	36·5	31·7	28·9	25·8	22·4	20	18·2	15·9	14·1
11,000	105	74·4	60·6	52·5	49·4	47·0	44·8	42·8	41·2	39·7	38·3	33·2	30	27·1	23·5	21	19·1	16·6	14·8
12,000	108·7	77·5	63·3	54·8	51·7	49·0	46·7	44·8	43·1	41·5	40	34·7	31·7	28·3	24·5	22	20	17·4	15·5
13,000	114·5	80·7	65·9	57·0	53·7	51·0	48·7	46·5	44·8	43·2	41·3	36·1	33	29·4	25·5	22·9	20·8	18	16·2
14,000	118·5	83·7	68·4	59·2	55·8	53·0	50·4	48·3	46·5	44·8	43·2	37·5	34·1	30·6	26·5	23·7	21·6	18·8	16·8
20,000	141·5	100	81·8	70·8	66·7	63·3	60·4	57·8	55·5	53·5	51·7	44·8	40·8	36·5	31·7	28·3	25·8	22·4	20

Exact Ratios are given, but a small deviation either way is permissible

Weight, Length and Resistance of Enamelled Copper Wire

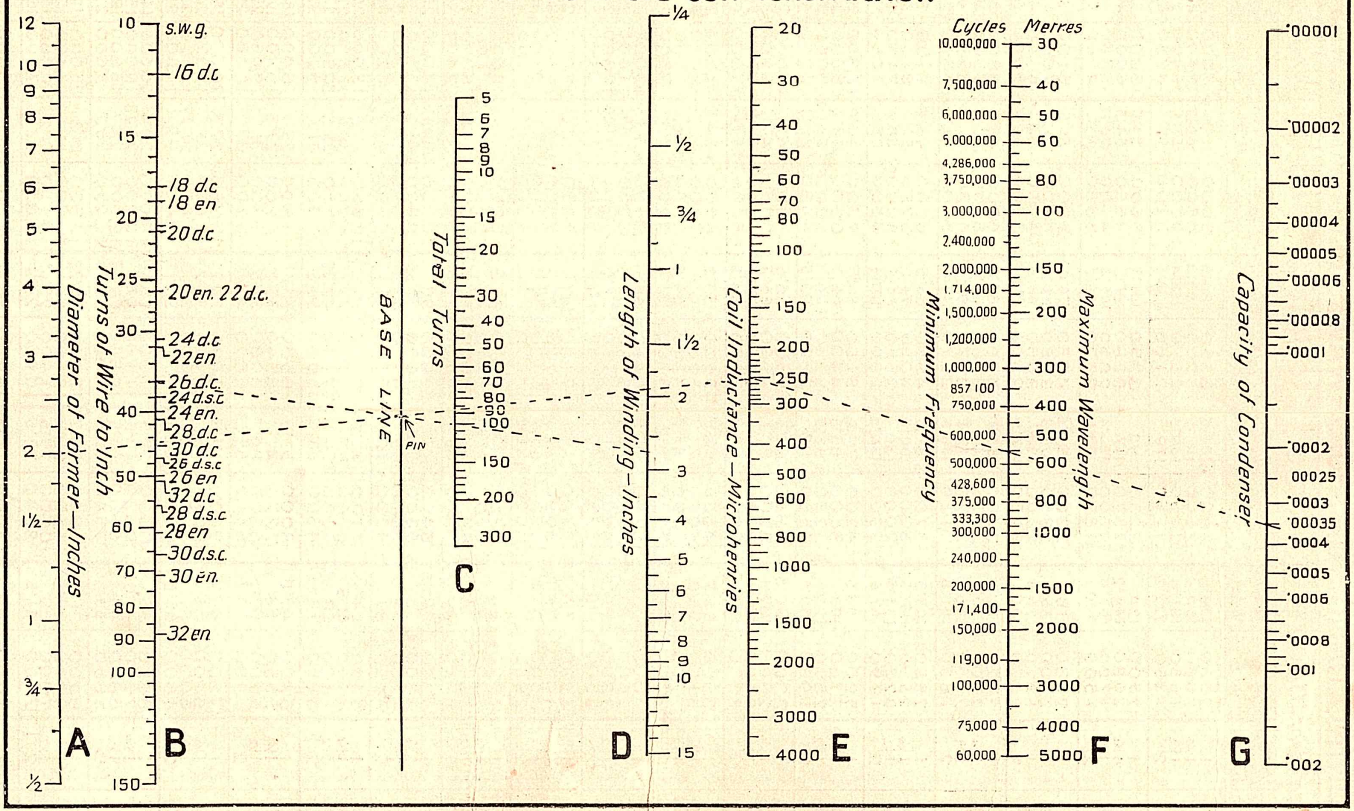


Turns for closed coils

The Radio Constructor's Wire Table

No.	Diam. Mils.		Cross-sectional Area		Turns to Inch						Ohms per 1000 ft.		Pounds per 1000 ft.						Amperes carried				Watts carried at 230 volts (Enclosed)		Nearest B&S to S.W.G.	No.
	B.&S.	S.W.G	Sq. Inch		B. & S.			S.W.G.					B. & S.			S.W.G.			Open Leads		Closed Coils					
			B. & S.	S.W.G.	En.	d.s.c.	d.c.c.	En.	d.s.c.	d.c.c.	B. & S.	S.W.G.	En.	d.s.c.	d.c.c.	En.	d.s.c.	d.c.c.	B.&S.	S.W.G.	B.&S.	S.W.G.	B.&S.	S.W.G.		
12	81	104	·005129	·008495	12·1		10·9	9·6		8·8	1·62		20·1		20·4	33·0		35·7	AMPS. 20·0	AMPS. 33·7	AMPS. 6·5	AMPS. 10·65	1500	1900		**12**
14	64	80	·003225	·005127	15·1		13	12·6		10·5	2·58		12·6		12·9	20·0		20·3	12·9	20·0	4·1	6·5	950	1500	12	**14**
16	51	64	·002028	·003217	18·9	18·3	16·7	14		13	4·09	2·491	7·9	8·0	8·21	12·40	12·8	13·0	8·0	12·9	2·6	4·1	600	950	14	**16**
18	40	48	·001276	·001810	23	22	20	19	19	18	6·51	4·46	4·9	5·02	5·24	6·97	7·3	7·4	5·1	6·1	1·6	2·0	370	460	16	**18**
20	32	36	·0008023	·001018	29	28	24	26	25	21	10·4	7·87	3·1	3·17	3·37	3·92	4·13	4·2	3·2	4·1	1·0	1·3	230	300	19	**20**
22	25·3	28	·0005046	·0006158	37	34	30	32	30	26	16·5	13·013	1·9	2·01	2·17	2·37	2·62	2·7	2·0	3·0	M.A. 640	M.A. 800	147	180	21	**22**
24	20·1	22	·0003173	·0003801	46	41	35	40	38	31	26·2	21·08	1·2	1·27	1·40	1·465	1·65	1·72	1·25	2·0	400	400	100	100	23	**24**
26	15·9	18	·0001996	·0002545	58	50	41	50	47	36	41·6	31·49	·785	·810	·914	·9806	1·08	1·13	M.A. 800	1·2	250	320	58	75	25	**26**
28	12·6	14·8	·0001255	·0001720	73	61	48	61	56	42	66·2	46·56	·494	·514	·608	·663	·703	·788	500	M.A. 700	160	200	37	45	27	**28**
30	10·0	12·4	·0000789	·0001208	91	72	55	71	66	45	105	66·36	·311	·333	·400	·465	·527	·57	310	480	100	130	23	30	28	**30**
32	8·0	10·8	·0000496	·0000916	115	84	62	88	75	51	167	87·46	·196	·217	·270	·353	·375	·415	200	365	63	100	14·5	23	30	**32**
34	6·3	9·2	·0000312	·0000665	145	99	70	98	85	56	266	120·5	·123	·141	·193	·2562	·297	·362	125	265	40	80	9·2	18·5	31	**34**
36	5·0	7·6	·0000156	·0000454	180	114	77	122	102	61	423	176·6	·078	·092	·136	·1748	·218	·264	63	183	25	50	5·8	11·5	33	**36**
38	4·0	6·0	·0000123	·0000283	227	128	83	143	120		673	283·4	·049	·062	·105	·1089	·124		50	113	16	32	3·7	7	34	**38**
40	3·1	4·8	·0000078	·0000181	286	145	90	180			1070	443	·031	·043	·084	·0697	·083		31	72	10	20	2·3	4·5	37	**40**
42	2·2	4·0	·0000038	·0000127	384			220			2100	638				·0484	·061		15	51	5	14	1·1	3·6	38	**42**
44	2·0	3·2	·0000031	·0000081	415			270			2480	996				·0310	·041		12	32	4	9	·9	2·7	39	**44**

Chart for Solenoid Coil Construction



For Shielded coils, allow about 10 per cent. extra turns when the shield is double the diameter of the coil, and up to 25 per cent. extra when the coil is more closely shielded.

TUNING RANGE OF SHORT-WAVE SECONDARY COILS

Condenser ·00025				·00015		·0001		·00005		Minimum	
Turns 24dsc (SWG)	Diam. Former INS	Max. K.C.	Approx Metres	Max. K.C.	Approx Metres	Max. K.C.	Approx. Metres	Max. K.C.	Approx. Metres	K.C.	Approx. Metres
30	1	2230	134·5	2900	103·5	3550	84·5	5000	60	7000	42·8
	1¼	2000	150	2600	116·4	3200	93·5	4500	66·5	6400	46·6
	1½	1650	181·8	2150	139·5	2670	112·4	3700	81·1	5400	55·5
	2	1350	222·2	1760	170·5	2160	138·5	3100	96·5	4750	63·2
26	1	2500	120	3250	92	3950	101·5	5600	53·5	8000	37·5
	1¼	2080	144·2	2570	117	3280	91·5	4650	64·5	6600	45·2
	1½	1790	167·6	2300	130·4	2850	105·3	4100	73·17	5750	52·2
	2	1500	200	1830	163·9	2370	126·5	3380	89	4800	62
24	1	2530	118	3300	90·5	4050	74·07	5800	51·5	8100	37
	1¼	2200	136·4	2850	105·3	3480	86·2	4900	61·2	7000	42·8
	1½	1920	156·3	2500	120	3050	98·5	4350	69	6150	49
	2	1570	191·1	2030	147·5	2500	120	3500	85·7	5000	60
22	1	2720	110·3	3600	83·3	4400	68·5	6200	48·2	8800	34·2
	1¼	2300	130·4	2970	101	3700	81·1	5200	57·2	7500	40
	1½	2050	146·3	2670	112·4	3270	91·5	4630	64·5	6550	45·5
	2	1650	181·8	2150	139·5	2670	112·4	3700	81·1	5300	56·2
20	1	2850	105·3	3700	81·8	4550	66·5	6500	46·2	9100	33
	1¼	2550	117·5	3300	90·5	4050	74·07	5750	52·2	8100	37·04
	1½	2230	134·5	2000	150	3550	84·5	5000	60	7150	41·96
	2	1790	167·6	2300	130·4	2800	107·1	4000	75	5650	53·5
18	1	3200	93·5	4200	71·5	5150	58·5	7300	41·10	10,300	29·2
	1¼	2760	109	3600	83·3	4400	68·5	6200	48·2	8800	34
	1½	2500	120	3250	92·5	3950	76	5600	53	8000	37·5
	2	1990	150·8	2550	118	3200	93·5	4430	67·3	6250	48
16	1	3300	90·5	4300	69·5	5300	56·5	7500	40	10,600	28·3
	1¼	2800	107·1	3700	81·1	4500	66·5	6350	47·2	9000	33·3
	1½	2400	125	3150	95·2	3860	77·7	5500	54·5	7550	39·7
	2	2230	134·5	2900	103·5	3550	84·5	5000	60	7000	42·8
14	1	3500	85·7	4550	66·5	5600	53·2	8000	37·5	11,300	26·2
	1¼	3150	95·2	4070	74	5000	60	7100	42·25	10,050	30
	1½	2700	111·1	3500	85·7	4300	69·5	6150	49	8700	34·5
	2	2300	130·4	2970	101	3700	81·1	5200	57·2	7300	41·1
12	1	4000	75·0	5250	57·5	6450	46·51	9100	33	13,000	23·08
	1¼	3600	83·3	4700	63·5	5750	52·4	8200	36·6	11,600	25·8
	1½	3300	90·5	4200	71·5	5150	58·5	7300	41·10	10,300	29
	2	2500	120	3250	92·2	3950	76	5600	53·4	8000	37·5
11	1	4230	71·07	5400	55·5	7100	42·25	8350	36	12,000	25
	1¼	4020	75	5020	59·5	6200	48·2	7600	39	10,900	27·5
	1½	3600	83·3	4300	69·5	5430	55·5	6500	46	8600	35
	2	2950	102·	3620	83	4500	67	5500	54·2	7500	40
10	1	4720	64	5880	51·02	7270	41·3	8950	33·52	13,000	23·08
	1¼	4300	70	5200	57·5	6410	47	8600	35	11,600	25·8
	1½	3940	76·1	4400	68	5600	53·5	7000	42·86	8970	33·7
	2	3250	92	3950	76	4900	61·5	591.0	50·7	7400	40·54
9	1	5330	56·06	6420	47	7900	38	9000	33·33	14,000	21·43
	1¼	4300	70	5800	51·6	7050	42·55	8800	34·2	12,550	23·8
	1½	4150	72·5	5000	60	6400	47	7840	38·2	9300	32·2
	2	3450	87	4300	70	5380	56	6500	46·2	8200	36·5
8	1	5560	54	7100	42·25	8650	35	10,860	27·5	15,000	20
	1¼	4900	61·5	6400	47	7700	39	9700	30·6	13,500	22·2
	1½	4420	68	5580	54·5	7100	42·25	8550	35·2	10,900	27·5
	2	3850	78	4500	66·5	5950	50·5	7300	41·1	9200	32·7
7	1	6300	47·8	8000	37·5	9500	31·7	11,900	25·1	16,000	18·75
	1¼	5560	54	7270	41	8540	35·2	10,800	27·5	15,400	19·5
	1½	5200	57·5	6500	46	8000	37·5	9700	31	12,050	25
	2	4250	70·5	5450	55·05	6800	44	8200	37	10,400	29
6	1	7100	42·5	9000	33·33	10,600	28·2	13,350	22·5	20,000	15
	1¼	6400	46	8050	37·1	9170	32·7	12,000	25	17,330	20·9
	1½	6000	50	7500	40	8600	35	11,000	27·27	13,650	23·7
	2	4600	65·5	6220	48	7700	39	9400	32	11,600	28·2
5	1	8580	35	10,300	29·5	11,900	25·1	14,670	20·4	20,600	14·5
	1¼	7200	41·67	9630	31·5	11,100	27	13,200	22·73	19,000	15·7
	1½	6800	44	8700	34·5	10,500	28·57	12,500	24	15,800	19
	2	5650	53	7540	39·8	9000	33·33	11,230	26·7	13,600	22
4	1	9600	31·8	11,800	25·2	13,200	22·73	16,360	18·3	25,000	12
	1¼	8000	37·5	11,600	25·7	12,500	24	15,800	19	23,400	12·8
	1½	7900	38	10,300	29·5	11,900	25·01	14,150	21·2	20,000	15
	2	7200	41·5	9340	32·5	10,950	27·3	13,050	23	17,800	16·8
3	1	10,000	30	13,660	22·06	14,680	20·4	18,300	16·3	25,500	11·7
	1¼	9800	30·4	13,300	22·56	14,000	21·43	17,950	16·8	24,200	12·4
	1½	9400	32	12,430	24·1	13,660	22	16,900	17·75	23,700	12·6
	2	8750	34·3	11,900	25·1	13,270	22·7	15,950	19·	23,000	12·87
2	1	10,800	28	14,600	20·6	16,200	18·5	18,450	16·25	26,000	11·4
	1¼	10,600	28·3	14,250	21	15,100	19·8	17,700	17	25,000	12
	1½	10,100	30	13,200	22·7	14,760	20·3	17,330	17·25	24,000	12·5
	2	9700	30·8	12,400	24	13,700	21·9	16,500	18·2	23,400	12·8

Table A. Small Power Transformers—Stalloy Cores, 230 volts, 50 cycles

	Watts	Core Section INS.	Turns per Volt	Primary Wire s.w.g	Primary Turns	Secondary Turns to give— VOLTS																			H.T. Secys.		Probable Full-Load Efficiency	Not applicable to Equivalent Cores				
						1 to 2 amps																			Wire Gauge	Max. Mills.		Spool Ends	Window (Max.)	Stalloy		
																														Cut Sizes		No. of 3 ft Lengths
						1·5	1·75	2·5	4	5	6	7·5	10	25	180	200	300	350	400	450	500	550	600	700						Long	Short	
1	50 Sankey	1 × 1 ¾ × 1⅜ 15/16 × 1⅛	9	28	1875	15	17	24	37	47	55	69	91	230	1620	1800	2700	3150	3600	4050	4500	4950	5400	6300	36	25	PER CENT. 70 75	2⅜ sq.	3 × ¾ 3¼ × ⅞	4 4¼	1¾ 1⅞	21 23
1·125	60	¾ × 1½ READY CUT STOCK	7·6	28	1700	12	14	21	33	41	47	59	78	200	1380	1525	2300	2650	3025	3420	3800	4200	4550	5320	36	35	75	2⅝ × 3⅜	2¾ × 1	3½	1¾	29
1·25	75	1 × 1¼ ¾ × 1⅝	6·7	26	1470	11	13	18	28	35	41	51	68	170	1200	1340	2000	2350	2680	3020	3350	3690	4000	4700	36	40	75	2⅞ × 2⅝	3¼ × ⅞	4¼	1⅞	28
1·5	90	1 × 1½ READY CUT STOCK	5·7	24	1230	10	12	17	26	31	35	45	58	146	1020	1140	1720	2000	2280	2600	2850	3130	3410	4000	34	50	80	3 7/16 × 2⅞	3 × 1	4	2	33
1·56	100	1¼ × 1¼ 1 × 1 9/16	5·5	24	1140	9	10	15	25	30	35	44	57	140	1000	1100	1660	1930	2200	2480	2760	3030	3300	3850	32	60	80	3⅜ sq.	3½ × 1	4¾	2¼	32
1·68	110	1¼ × 1⅜ ¾ × 2¼ ½ × 1⅛	5·36 4"	22 32	1125	9	10	15	24	29	34	43	56	137	970	1080	1630	1900	2150	2400	2700	2960	3250	3750	32	70	85	4 × 3¾	3⅝ × 1⅜	5⅛	2⅝	40
2·25	150 Sankey	1½ × 1½ 1¼ × 1¾ 15/16 × 2 5/16	3·75	22	850	6-7	8	10	16	19	23	29	38	94	670	750	1120	1310	1490	1680	1870	2050	2230	2600	30	90	90	4⅞ sq.	5 × 1¾	6½	3¼	54
3·5	200	1¾ × 1¾ 1½ × 2 1⅝ × 1⅞	2·7	20 d.c.c.	610	4-5	5	7	11	14	17	22	27	68	490	540	815	960	1100	1230	1360	1500	1630	1900	28	130	90	5¾ sq.	5½ × 2	7¼	3¾	69
4	300	2 × 2 1½ × 2⅝ 1¾ × 2¼	2·1	18 d.c.c.	470	3-4	4	6	9	11	13	17	21	53	380	420	635	740	845	950	1050	1155	1260	1470	26	200	90	6⅜ sq.	6 × 2¼	8	4¼	88

"Radio Times" Standard Audio Choke Specifications

Ref.	Inductance Henrys	Current m.a.	Total Gap ½ea	Flux Kilolines	Turns	Enam Wire s.w.g.	Weight Wire		Core Square	STALLOY					D.C. Resistance OHMS	VOLTS DROPPED MILLS. PASSING							Window	SPOOL		Chief Purpose
							lb.	oz.		W	X	Y	Z	3 ft Strip		70	80	90	100	120	150	200		Ends (Square)	Outside Length	
1	20	200	·1	35	5500	26	4		1½	6·5	5	2·6	1·1	42	156	11	12	14	15	19	22	30	3·5×1·1	3·6	3·5	*Heavy Smoothing* *
2	25	150	·075	35	6000	26	4	4	1½	6·5	5	2·6	1·1	42	168	12	13	15	16	20	25		3·5×1·1	3·6	3·5	" " *
3	20	120	·06	35	5760	30	1	13	1¼	5	3·75	2·05	·8	27	254	18	20	22	25	30			2·5×·8	2·65	2·4	" "
																30	**40**	**50**	**60**	**70**	**80**	**90**				
4	30	90	·04	37	5650	30	1	10	1¼	4·7	3·45	1·95	·7	25	270	8	11	13	16	19	21	24	2·2×·7	2·5	2·1	" "
5	25	80	·05	35	7000	32	1	8	1	4·3	3·3	1·8	·8	19	370	11	14	18	21	25	29	31	2·3×·8	2·5	2·3	*Smoothing*
6	40	80	·05	35	6900	32	1	9	1¼	4·5	3·25	1·95	·7	24	380	12	15	19	22	26	30	32	2×·7	2·5	2	"
7	28	80	·05	35	6900	32	1	7	1	4	3	1·67	·67	17	330	10	13	16	20	22	26	30	2×·67	2·2	2	"
8	30	50	·03	33	6000	32	1	2	1	4·25	3·25	1·6	·6	18	275	8	11	13	16				2·25×·6	2	2·2	*Heavy Output* †
9	20	80	·04	35	5500	34		12	1	3·5	2·5	1·6	·6	16	355	11	14	18	21				1·5×·6	2·1	1·5	*Smoothing*
10	23	50	·02	35	4200	36		5	1	3·5	2·5	1·3	·3	14	327	10	13	16	20	22	26	30	1·5×·3	1·5	1·5	"
11	15	80	·04	30	4600	34		10	1	3·5	2·5	1·6	·6	16	294	9	12	15	18	20	22	26	1·5×·6	2·1	1·5	"
12	10	50	·04	15	3800	36		4·5	1	3·5	2·5	1·3	·3	14	478	15	20	25	30				1·5×·3	1·5	1·5	"
																2	**3**	**5**	**20**	**25**	**30**	**35**				
13	200	10	·03	20	15,000	40		9	1	3·5	2·5	1·6	·6	16	3480	7	10	18					1·5×·6	2·1	1·5	*Det. Smoothing or Plate*
14	500	3	NONE	35	18,000	44		4	1	3·6	2·6	1·5	·5	15	5360	10	16						1·6×·5	1·9	1·6	*Plate Impedance* ‖
15	35	35	·02	18	6700	36		11	1	3·5	2·5	1·6	·6	16	640				13	16	20	22	1·5×·6	2·1	1·5	*General Output* §

** Layer Wound . † Taps 2000, 3000 § Taps 2233, 3350 ‖ 4 "Pie" Sections*

A "TEN-PER-CENT. tap" should be incorporated in a choke for the first smoothing position, or if it is the only one, as explained in the "Facts" Section.

Nos. 1 and 2 are suited for smoothing for a dance-hall amplifier or "ham" transmitter, and 3 and 4 for heavy receiver and amplifier duty.

Nos. 5, 7 and 8 are good standard power-pack chokes for broadcast or short-wave work, and

No. 6 may be used as a second smoothing choke when the speaker field is not used.

Nos. 9 and 10 suit small receivers.

Nos. 11, 12 and 13 are good auxiliary chokes for extra smoothing (detector) or de-coupling.

No. 14 is for detector plate supply in place of resistance or transformer primary.

No. 15 is for magnetic speaker output from power pentode, tapped at 2233 and 3350 turns for ratios. It is also suited for the single choke of a small power-supply.

The gap given is correct for the maximum current, but if less is passing the gap may be reduced and the inductance thereby raised. If possible, loosen the clamps and adjust the gap under load until hum is at a minimum.

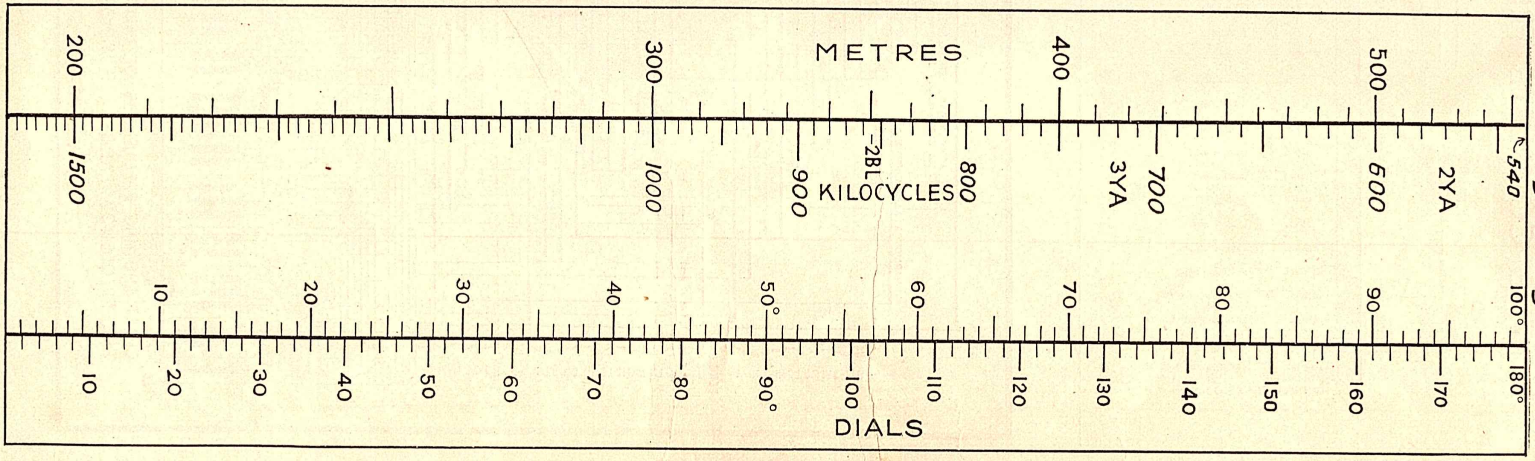
THE INTERNATIONAL MORSE CODE

A	· —	K	— · —	U	· · —
B	— · · ·	L	· — · ·	V	· · · —
C	— · — ·	M	— —	W	· — —
D	— · ·	N	— ·	X	— · · —
E	·	O	— — —	Y	— · — —
F	· · — ·	P	· — — ·	Z	— — · ·
G	— — ·	Q	— — · —	*General Call*	— · — · — — · —
H	· · · ·	R	· — ·	*Attention Call*	— · — · —
I	· ·	S	· · ·	*End of Message*	· — · — ·
J	· — — —	T	—	*End of Transmission*	· · · — · —
1	· — — — —	6	— · · · ·	*"Go Ahead" transmitting*	— · —
2	· · — — —	7	— — · · ·	*Received (O.K.)*	· — ·
3	· · · — —	8	— — — · ·	*Interrogation ?*	· · — — · ·
4	· · · · —	9	— — — — ·	*Period (.)*	· · · · · ·
5	· · · · ·	0	— — — — —	*Double Dash*	— · · · —
		Comma	· — · — · —	*Distress Signal*	· · · — — — · · ·

Current Capacity (Mills.)					Voltage			
OHMS	Watts 1	2	3	5	W 1	2	3	5
1,000,000	1 m.a.	1.4	1.7	2	1,000 v.	1,400	1,700	2,200
500,000	1.4	2	2.5	3	700	1,000	1,200	1,600
250,000	2	2.8	3.5	4.5	500	700	870	1,100
100,000	3	4.5	5.5	7	315	450	550	710
50,000	4.5	6.5	8	10	220	315	390	500
30,000	6	8	10	13	170	250	300	390
20,000	7	10	12	16	140	200	240	310
10,000	10	14	17	22	100	140	170	220
7,500	12	16	20	26	87	120	150	200
5,000	14	20	25	32	70	100	120	160
3,000	18	26	32	41	55	78	95	120
2,000	22	32	39	50	45	63	78	100
1,000	31	45	55	70	31	45	55	71
750	37	52	63	82	27	38	47	62
500	45	63	78	100	22	32	39	50
300	59	82	100	130	17	24	30	39
200	72	100	120	160	14	20	24	32
100	100	140	175	220	10	14	17	22
50	140	200	250	320	7	10	12	16

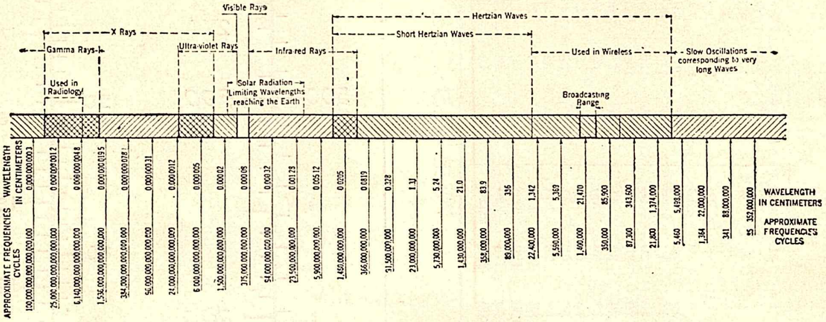
See "Facts" Section

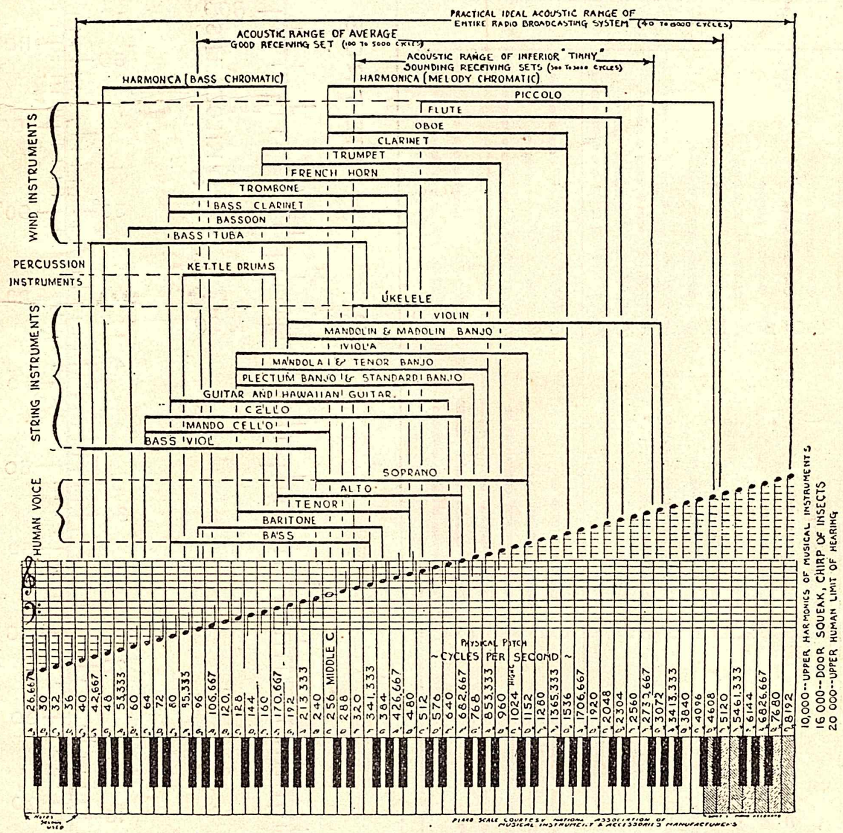
Tuning Range



See "Facts" Section

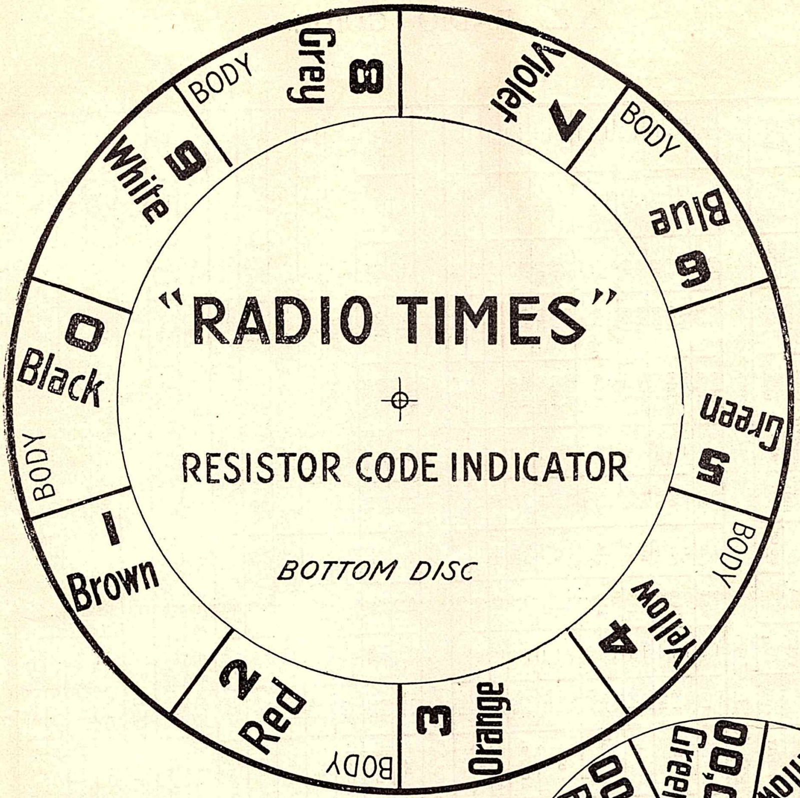
THE COMPLETE FREQUENCY SPECTRUM

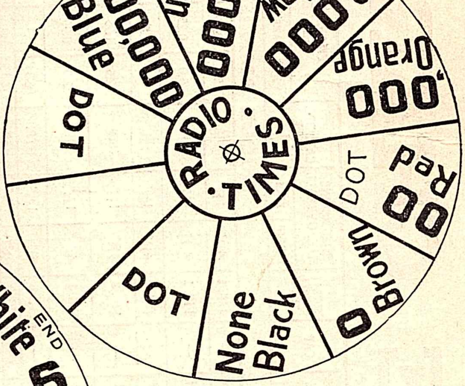




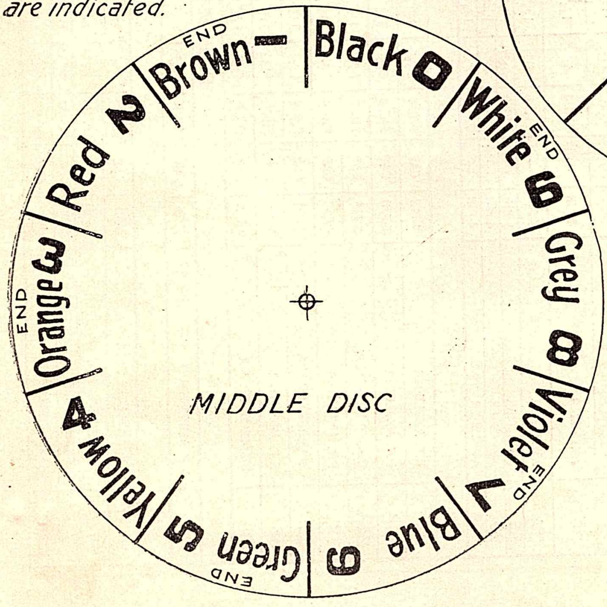
PIANO SCALE COURTESY NATIONAL ASSOCIATION OF MUSICAL INSTRUMENT & ACCESSORIES MANUFACTURERS

CHART SHOWING FREQUENCIES OF VARIOUS NOTES ON A PIANO KEYBOARD AND THE FREQUENCY RANGES OF VARIOUS MUSICAL INSTRUMENTS





Mount on card, dry between clean paper under pressure, cut out the three circles, and with the smallest on top, pass a thin bolt through the centre with washers, or with a drawing-pin attach to piece of thick card or 3-ply. Rotate the discs to bring the required figures in line, and the colours are indicated.



This Resistor Indicator Clock, when assembled according to the instructions, provides an accurate and sure method of determining the value of any colour coded resistor, or, conversely, the coding of a wanted resistor can be read off instantly.

Those who would rather not mutilate their copies of the "1934 Radio Guide" can obtain the finished clock, printed on durable, white-lined strawboard and securely riveted, from Box 1680, Wellington. Price 1/-, including packing and postage.

VALVE CHARACTERISTICS

TYPE	APPLICATION	BASE	CAP	SOCKET CONNECTIONS	DIMENSIONS MAX. OVERALL		CATHODE TYPE	FILAMENT OR HEATER			PLATE SUPPLY VOLTS	SCREEN VOLTS	NEGATIVE GRID BIAS VOLTS		PLATE CURRENT MILLI-AMP.	SCREEN CURRENT MILLI-AMP.	A C PLATE RESISTANCE OHMS.	MUTUAL CONDUCTANCE MICRO-MHOS	VOLTAGE AMPLIFICATION FACTOR	OHMS LOAD FOR STATED POWER OUTPUT	POWER OUTPUT MILLI-WATTS
					LENGTH	DIAM		VOLTS	AMPS.	SUPPLY	* MAX.	* MAX.	D C ON FIL.	A C ON FIL.							
TRIODE AMPLIFIER VALVES																					
01A	AMPLIFIER	4-PIN	—	FIG. 1	4 11/16"	1 13/16"	FIL.	5.0	0.25	D C	90 135*	— —	4.5 9.0	— —	2.5 3.0	— —	11000 10000	725 800	8.0 8.0	— —	— —
12A	AMPLIFIER	4-PIN	—	FIG. 1	4 11/16"	1 13/16"	FIL.	5.0	0.25	D C	90 135 180*	— — —	4.5 9.0 13.5	— — —	5.0 6.2 7.7	— — —	5400 5100 4700	1575 1650 1800	8.5 8.5 8.5	5000 9000 10650	35 130 285
26	AMPLIFIER	4-PIN	—	FIG. 1	4 11/16"	1 13/16"	FIL.	1.5	1.05	A C or D C	135 180*	— —	9.0 13.5	10.0 14.5	5.5 6.2	— —	7600 7300	1100 1150	8.3 8.3	— —	— —
27	AMPLIFIER	5-PIN	—	FIG. 8	4 11/16"	1 13/16"	HTR.	2.5	1.75	A C or D C	135 250 275*	— — —	9.0 21.0 —	9.0 21.0 —	4.5 5.2 —	— — —	9000 9250 —	1000 975 —	9.0 9.0 —	— — —	— — —
30	AMPLIFIER	4-PIN	—	FIG. 1	4 1/4"	1 9/16"	FIL.	2.0	0.06	D C	90 135 180*	— — —	4.5 9.0 13.5	— — —	2.5 3.0 3.1	— — —	11000 10300 10300	850 900 900	9.3 9.3 9.3	— — —	— — —
37	AMPLIFIER	5-PIN	—	FIG. 8	4 1/4"	1 9/16"	HTR.	6.3	0.3	A C or D C	180 250*	— —	13.5 18.0	13.5 18.0	4.3 7.5	— —	10200 8400	900 1100	9.2 9.2	— —	— —
56	AMPLIFIER	5-PIN	—	FIG. 8	4 1/4"	1 9/16"	HTR.	2.5	1.0	A C or D C	250*	—	13.5	13.5	5.0	—	9500	1450	13.8	—	—
99	AMPLIFIER	4-PIN	—	FIG. 1	4 1/8"	1 3/16"	FIL.	3.3	0.063	D C	90*	—	4.5	—	2.5	—	15500	425	6.6	—	—
864	AMPLIFIER	4-PIN	—	FIG. 1	4"	1 3/16"	FIL.	1.1	0.25	D C	135*	—	9.0	—	3.5	—	12700	645	8.2	—	—
SCREEN GRID VALVES																					
22	R.F. AMPLIFIER	4-PIN	CAP	FIG. 4	5 1/32"	1 13/16"	FIL.	3.3	0.132	D C	135 135*	45 67.5*	1.5 1.5	— —	1.7 3.7	0.6 1.3	725000 325000	375 500	270 160	— —	— —
24A	R.F. AMPLIFIER	5-PIN	CAP	FIG. 9	5 1/32"	1 13/16"	HTR.	2.5	1.75	A C or D C	180 250*	90* 90*	3.0 3.0	3.0 3.0	4.0 4.0	1.7 max.	400000 600000	1000 1050	400 630	— —	— —
24A	BIASED DETECTOR	5-PIN	CAP	FIG. 9	5 1/32"	1 13/16"	HTR.	2.5	1.75	A C or D C	275*	20 to 45	5.0 approx.	5.0 approx.	Plate current adjusted to 0.1 ma. (no signal) Plate coupling resistor 250000 ohms.						
32	R.F. AMPLIFIER	4-PIN	CAP	FIG. 4	5 1/32"	1 13/16"	FIL.	2.0	0.06	D C	135 180*	67.5* 67.5*	3.0 3.0	— —	1.7 1.7	0.4 max.	950000 1200000	640 650	610 780	— —	— —
32	BIASED DETECTOR	4-PIN	CAP	FIG. 4	5 1/32"	1 13/16"	FIL.	2.0	0.06	D C	135 180*	45 67.5*	4.5 6.0	approx.	Plate current adjusted to 0.2 ma. (no signal) Plate coupling resistor 100000 ohms						
36	R.F. AMPLIFIER	5-PIN	CAP	FIG. 9	4 17/32"	1 9/16"	HTR.	6.3	0.3	A C or D C	180 250*	90* 90*	3.0 3.0	3.0 3.0	3.1 3.2	1.7 max.	500000 550000	1050 1080	525 595	— —	— —
36	BIASED DETECTOR	5-PIN	CAP	FIG. 9	4 17/32"	1 9/16"	HTR.	6.3	0.3	A C or D C	180 250*	67.5 90*	6.0 approx. 8.0 approx.	Plate current adjusted to 0.1 ma (no signal) Plate coupling resistor 250000 ohms.							
SUPER-CONTROL SCREEN GRID VALVES																					
35	R.F. AMPLIFIER	5-PIN	CAP	FIG. 9	5 1/32"	1 13/16"	HTR.	2.5	1.75	A C or D C	180 250*	90* 90*	3.0 min.	3.0 min.	6.3 6.5	2.5 max.	300000 400000	1020 1050	305 420	— —	— —
R.F. PENTODE VALVES																					
57	R.F. AMPLIFIER	6-PIN	CAP	FIG. 11	4 11/16"	1 9/16"	HTR.	2.5	1.0	A C or D C	250*	100*	3.0	3.0	2.0	0.5	exceeds 1.5 meg.	1225	exceeds 1500	—	—
57	BIASED DETECTOR	6-PIN	CAP	FIG. 11	4 11/16"	1 9/16"	HTR.	2.5	1.0	A C or D C	275*	100*	6.0 approx.	6.0 approx.	Plate current adjusted to 0.1 ma. (no signal) Plate coupling resistor 250000 ohms.						
77	R.F. AMPLIFIER	6-PIN	CAP	FIG. 11	4 17/32"	1 9/16"	HTR.	6.3	0.3	A C or D C	250*	100*	3.0	3.0	2.3	0.6	1.5 meg.	1250	1500	—	—
77	BIASED DETECTOR	6-PIN	CAP	FIG. 11	4 17/32"	1 9/16"	HTR.	6.3	0.3	A C or D C	250*	100*	7.0 approx.	7.0 approx.	Plate current adjusted to 0.1 ma. (no signal) Plate coupling resistor 250000 ohms.						

Above Radiotron Characteristics by courtesy A.W.A. Ltd.

RCA

SUPER-PHONIC

RADIOTRONS

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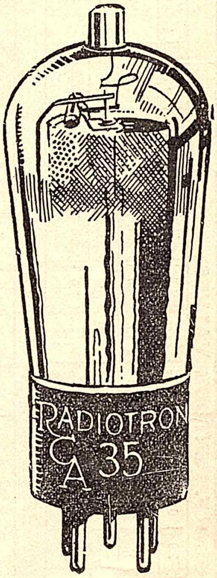

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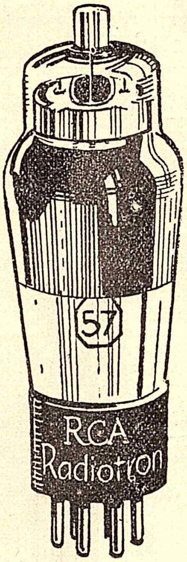


Amalgamated Wireless (A/sia) Ltd.

World Wide Wireless

P.O. Box 830,
WELLINGTON.

SUPER-CONTROL R.F. PENTODE VALVES

34	R.F. AMPLIFIER	4-PIN	CAP	FIG. 4A	5 1/32"	1 13/16"	FIL.	2.0	0.06	DC	135 180*	67.5* 67.5*	3.0 min.	— —	2.8 2.8	1.0 1.0	600000 1 meg.	600 620	360 620	— —	— —
39 44	R.F. AMPLIFIER	5-PIN	CAP	FIG. 9A	4 17/32"	1 9/16"	HTR.	6.3	0.3	AC or DC	180 250*	90* 90*	3.0 min.	3.0 min.	5.8 5.8	1.4 1.4	750000 1 meg.	1000 1050	750 1050	— —	— —
58	R.F. AMPLIFIER	6-PIN	CAP	FIG. 11	4 15/16"	1 9/16"	HTR.	2.5	1.0	AC or DC	250*	100*	3.0 min.	3.0 min.	8.2	2 0	800000	1600	1280	—	—
78	R.F. AMPLIFIER	6-PIN	CAP	FIG. 11	4 17/32"	1 9/16"	HTR.	6.3	0.3	AC or DC	180 250* 250*	75 100 125*	3.0 min.	3.0 min.	4.0 7.0 10.5	1.0 2.0 3.0	1 meg. 800000 600000	1100 1450 1650	1100 1160 990	— — —	— — —

CONVERTER VALVES (Combined First Detector Oscillator)

1A6	PENTAGRID ‡	6-PIN	CAP	FIG. 10	4 17/32"	1 9/16"	FIL.	2.0	0.06	DC	135 180*	67.5* 67.5*	3.0 min.	—	1.2 1.3	2.5 2.4	400000 500000	Anode grid (2) 135* Volts 2.3 ma. Oscill. grid (1) resistor 50000 ohms. Conversion Conductance 300 micromhos.			
2A7 6A7	PENTAGRID ‡	small 7-PIN	CAP	FIG. 20	4 17/32"	1 9/16"	HTR.	2.5 6.3	0.8 0.3	AC or DC	250*	100*	3.0 min.	3.0 min.	3.5	2.2	300000	Anode grid (2) 200* Volts Oscill. grid (1) resistor 50000 ohms. Conversion Conductance 520 micromhos.			

‡ Grids Nos. 3 and 5 are Screen, Grid No. 4 is signal input control grid.

DUO-DIODE DETECTOR VALVES

55 85	DUO-DIODE TRIODE	6-PIN	CAP	FIG. 13	4 17/32"	1 9/16"	HTR.	2.5 6.3	1.0 0.3	AC or DC	250*	—	20.0	20.0	8.0	—	7500	1100	8.3	20000	350
75 2A6	DUO-DIODE HIGH MU TRIODE	6-PIN	CAP	FIG. 13	4 17/32"	1 9/16"	HTR.	6.3 2.5	0.3 0.8	AC or DC	250*	—	2.0	2.0	Plate coupling resistor 100000 ohms. 0.8	—	91000	1100	100	—	—
2B7 6B7	DUO-DIODE PENTODE (A.F.)	small 7-PIN	CAP	FIG. 21	4 17/32"	1 9/16"	HTR.	2.5 6.3	0.8 0.3	AC or DC	250*	50	4.5	4.5	0.65	0.15	Plate coupling resistor 200000 ohms.				
2B7 6B7	DUO-DIODE PENTODE (R.F.)	small 7-PIN	CAP	FIG. 21	4 17/32"	1 9/16"	HTR.	2.5 6.3	0.8 0.3	AC or DC	250*	125*	3.0	3.0	9.0	2.3	650000	1125	730	—	—

TRIODE POWER VALVES (Class A)

2A3	SINGLE TRIODE	4-PIN	—	FIG. 1	5 3/8"	2 1/16"	FIL.	2.5	2.5	AC or DC	250*	—	43	45	60	—	765	5500	4.2	2500	3500
2A3	PUSH-PULL TRIODES (2 Valves)	4-PIN	—	FIG. 1	5 3/8"	2 1/16"	FIL.	2.5	each 2.5	AC or DC	300*	—	60	62	each 40	—	Fixed bias Self bias (700 ohms.)			3000 5000	15000 10000
10	SINGLE TRIODE	4-PIN	—	FIG. 1	5 5/8"	2 3/16"	FIL.	7.5	1.25	AC or DC	350 425*	— —	27 35	31 39	16 18	— —	5150 5000	1550 1600	8.0 8.0	11000 10200	900 1600
20	SINGLE TRIODE	4-PIN	—	FIG. 1	4 1/8"	1 3/16"	FIL.	3.3	0.132	DC	90 135*	— —	16.5 22.5	— —	3.0 6.5	— —	8000 6300	415 525	3.3 3.3	9600 6500	45 110
31	SINGLE TRIODE	4-PIN	—	FIG. 1	4 1/4"	1 9/16"	FIL.	2.0	0.130	DC	135 180*	— —	22.5 30.0	— —	8.0 12.3	— —	4100 3600	925 1050	3.8 3.8	7000 5700	185 375
45	SINGLE TRIODE	4-PIN	—	FIG. 1	5 5/8"	2 3/16"	FIL.	2.5	1.5	AC or DC	180 250 275*	— — —	30.0 48.5 54.5	31.5 50 56	31 34 36	— — —	1650 1610 1700	2125 2175 2050	3.5 3.5 3.5	2700 3900 4600	825 1600 2000
46	DUAL PURPOSE USED AS SINGLE TRIODE □	5-PIN	—	FIG. 7	5 5/8"	2 3/16"	FIL.	2.5	1.75	AC or DC	250*	—	31.5	33.0	22	—	2380	2350	5.6	6400	1250
50	SINGLE TRIODE	4-PIN	—	FIG. 1	6 1/4"	2 11/16"	FIL.	7.5	1.25	AC or DC	350 450*	— —	59.0 80.0	63.0 84.0	45 55	— —	1900 1800	2000 2100	3.8 3.8	4100 4350	2400 4600
53	TWIN CLASS B USED AS SINGLE TRIODE △	Medium 7-PIN	—	FIG. 17	4 11/16"	1 13/16"	HTR.	2.5	2.0	AC or DC	250 294*	— —	5.0 6.0	5.0 6.0	6.0 7.0	— —	11300 11000	3100 3200	35 35	approx. 30000	approx. 400
59	TRIPLE PURPOSE USED AS SINGLE TRIODE ¶	Medium 7-PIN	—	FIG. 18	5 3/8"	2 1/16"	HTR.	2.5	2.0	AC or DC	250*	—	28	28	26	—	2400	2600	6.0	5000	1250
71A	SINGLE TRIODE	4-PIN	—	FIG. 1	4 11/16"	1 13/16"	FIL.	5.0	0.25	AC or DC	135 180*	— —	27.0 40.5	29.5 43.0	17.3 20.0	— —	1820 1750	1650 1700	3.0 3.0	3000 4800	400 790
89	TRIPLE PURPOSE USED AS SINGLE TRIODE ¶	6-PIN	—	FIG. 14	4 17/32"	1 9/16"	HTR.	6.3	0.4	AC or DC	180 250*	— —	22.5 31.0	22.5 31.0	20 32	— 2	3000 2600	1550 1800	4.7 4.7	6500 5500	400 900
49	DUAL PURPOSE USED AS SINGLE TRIODE □	5-PIN	—	FIG. 7	4 11/16"	1 13/16"	FIL.	2.0	0.12	DC	135*	—	20	—	5.7	—	4000	1125	4.5	8000	170

¶ Grid No. 1 is Control grid. Grids Nos. 2 and 3 tied to plate. Above Radiotron Characteristics courtesy A.W.A. Ltd. □ Grid No. 2 tied to plate. △ Grids tied, plates tied together

PENTODE POWER VALVES (Class A)

2A5	PENTODE	6-PIN	—	FIG.15A	4 11/16"	1 13/16"	HTR.	2.5	1.75	AC or DC	250*	250*	16.5	16.5	34	6.5	100000	2200	220	7000	3000
6A4	PENTODE	5-PIN	—	FIG. 6	4 11/16"	1 13/16"	FIL.	6.3	0.3	AC or DC	180*	180*	12	15	22	3.9	45500	2200	100	8000	1400
33	PENTODE	5-PIN	—	FIG. 6	4 11/16"	1 13/16"	FIL.	2.0	0.26	DC	135*	135*	13.5	—	14.5	3.0	50000	1450	70	7000	700
38	PENTODE	5-PIN	CAP	FIG. 9A	4 17/32"	1 9/16"	HTR.	6.3	0.3	AC or DC	180 250*	180 250*	18 25	18 25	14 22	2.4 3.8	110000 100000	1050 1200	120 120	11600 10000	1000 2500
41	PENTODE	6-PIN	—	FIG.15A	4 1/4"	1 9/16"	HTR.	6.3	0.4	AC or DC	180 250*	180 250*	13.5 18.0	13.5 18.0	18.5 32.0	3.0 5.5	81000 68000	1850 2200	150 150	9000 7600	1500 3400
42	PENTODE	6-PIN	—	FIG.15A	4 11/16"	1 13/16"	HTR.	6.3	0.7	AC or DC	250*	250*	16.5	16.5	34	6.5	100000	2200	220	7000	3000
43	PENTODE	6-PIN	—	FIG.15A	4 11/16"	1 13/16"	HTR.	25	0.3	AC or DC	95 135*	95 135*	15 20	15 20	20 34	4.0 7.0	45000 35000	2000 2300	90 80	4500 4000	900 2000
47	PENTODE	5-PIN	—	FIG. 6	5 5/8"	2 3/16"	FIL.	2.5	1.75	AC or DC	250*	250*	15.0	16.5	31	6.0	60000	2500	150	7000	2700
48	PENTODE	6-PIN	—	FIG. 15	5 3/8"	2 1/16"	HTR.	30	0.4	DC	95 125*	95 100*	20.0 22.5	— —	47 50	9.0 9.0	10000 10000	2800 2800	28 28	2000 2000	1600 2500
59	TRIPLE PURPOSE USED AS PENTODE •	Medium 7-PIN	—	FIG. 18	5 3/8"	2 1/16"	HTR.	2.5	2.0	AC or DC	250*	250*	18	18	35	9.0	40000	2500	100	6000	3000
89	TRIPLE PURPOSE USED AS PENTODE •	6-PIN	CAP	FIG. 14	4 17/32"	1 9/16"	HTR.	6.3	0.4	AC or DC	180 250*	180 250*	18 25	18 25	20 32	3.0 5.5	80000 70000	1550 1800	125 125	8000 6750	1500 3400

• Grid No. 1 is Control grid. Grid No. 3 is Suppressor (tied to Cathode).
Grid No. 2 is Screen

CLASS B. POWER VALVES

46	TWO SEPARATE VALVES ×	5-PIN	—	FIG. 7	5 5/8"	2 3/16"	FIL.	2.5	each 1.75	AC or DC	300 400*	— —	0 0	0 0	4.0 6.0	Each valve no signal			Load plate to plate	5200 5800	16000 20000
49	TWO SEPARATE VALVES ×	5-PIN	—	FIG. 7	4 11/16"	1 13/16"	FIL.	2.0	0.12	DC	180*	—	0	—	2.0	Each valve no signal			Load plate to plate	— 12000	— 3500
59	TWO SEPARATE VALVES +	Medium 7-PIN	—	FIG. 18	5 3/8"	2 1/16"	HTR.	2.5	2.0	AC or DC	300 400*	— —	0 0	0 0	10 13	Each valve no signal			Load plate to plate	4600 6000	15000 20000
89	TWO SEPARATE VALVES +	6-PIN	CAP	FIG. 14	4 17/32"	1 9/16"	HTR.	6.3	0.4	AC or DC	180 250*	— —	0 0	0 0	3 —	Each valve no signal			Load plate to plate	9400 —	3500 —
19	TWIN VALVE	6-PIN	—	FIG. 12	4 1/4"	1 9/16"	FIL.	2.0	0.26	DC	135* 135* 135*	— — —	0 3 6	— — —	10 4 1	Total Ip. no signal			Load plate to plate	10000 10000 10000	2100 1900 1600
53	TWIN VALVE	Medium 7-PIN	—	FIG. 17	4 11/16"	1 13/16"	HTR.	2.5	2.0	AC or DC	250 300*	— —	0 0	0 0	28 35	Total Ip. no signal			Load plate to plate	8000 10000	8000 10000
79	TWIN VALVE	6-PIN	CAP	FIG. 19	4 17/32"	1 9/16"	HTR.	6.3	0.6	AC or DC	180 250*	— —	0 0	0 0	7.5 10.5	Total Ip. no signal			Load plate to plate	7000 14000	5500 8000

× Both Grids tied together in each valve.
+ Grids Nos. 1 and 2 tied together, No. 3 to plate.

RECTIFIER VALVES

TYPE	DESCRIPTION	BASE	CAP	SOCKET CONNECTIONS	DIMENSIONS MAX. OVERALL		CATHODE TYPE	FILAMENT OR HEATER			MAX. VOLTS HEATER TO CATHODE	MAX. A C VOLTS (R.M.S.) PER PLATE	MAX. PEAK INVERSE VOLTS	MAX. CONTINUOUS D C OUTPUT CURRENT (m.a.)	MAX. PEAK PLATE CURRENT (m.a.)
					LENGTH	DIAM.		VOLTS	AMPS.	SUPPLY					
5Z3	FULL WAVE VACUUM	4-PIN	—	FIG. 2	5 3/8"	2 1/16"	FIL.	5.0	3.0	AC	—	500	—	250	—
25Z5	VOLTAGE DOUBLER FULL WAVE VACUUM	6-PIN	—	FIG. 5	4 1/4"	1 9/16"	HTR.	25	0.3	AC or DC	125	125	—	100	—
80	FULL WAVE VACUUM	4-PIN	—	FIG. 2	4 11/16"	1 3/4"	FIL.	5.0	2.0	AC	—	350 400 550	—	125 110 135	The 550 volt rating applies only with 20 Henry input choke.
84	FULL WAVE VACUUM	5-PIN	—	FIG. 23	4 1/4"	1 9/16"	HTR.	6.3	0.5	AC or DC	300	225	—	50	—
12Z3	HALF WAVE VACUUM	4-PIN	—	FIG. 22	4 1/4"	1 9/16"	HTR.	12.6	0.3	AC or DC	350	250	—	60	—
1V	HALF WAVE VACUUM	4-PIN	—	FIG. 22	4 1/4"	1 9/16"	HTR.	6.3	0.3	AC or DC	500	350	—	50	—
81	HALF WAVE VACUUM	4-PIN	—	FIG. 3	6 1/4"	2 7/16"	FIL.	7.5	1.25	AC	—	700	—	85	—
82	FULL WAVE MERCURY†	4-PIN	—	FIG. 2	4 11/16"	1 13/16"	FIL.	2.5	3.0	AC	—	500	Plate to plate 1400	125	400
83	FULL WAVE MERCURY†	4-PIN	—	FIG. 2	5 3/8"	2 1/16"	FIL.	5.0	3.0	AC	—	500	Plate to plate 1400	250	800
866	HALF WAVE MERCURY†	4-PIN	CAP.	FIG. 16	6 5/8"	2 7/16"	FIL.	2.5	5.0	AC	—	—	7500	—	600

† Valve voltage drop 15 volts approx.
Max. voltage heater to cathode, 45 volts, except for Rectifiers, which are separately tabulated.

Above Radiotron Characteristics by courtesy A.W.A. Ltd.

SOCKET CONNECTIONS

(VIEWED FROM UNDERNEATH)

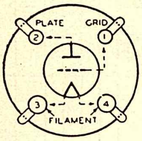


FIG. 1

01A, 10, 12A, 20, 26, 30, 31, 45, 50, 71A, 99, 864, 2A3

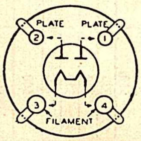


FIG. 2

80, 82, 83, 5Z3

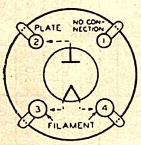


FIG. 3

81

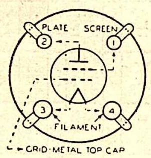


FIG. 4

22, 32

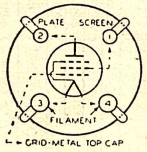


FIG. 4A

34

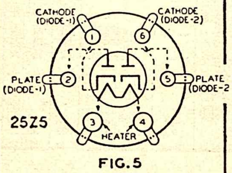


FIG. 5

25Z5

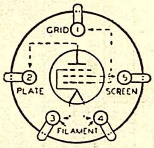


FIG. 6

33, 47, 6A4

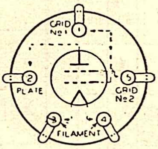


FIG. 7

46, 49

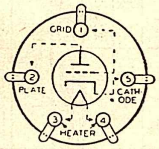


FIG. 8

27, 37, 56

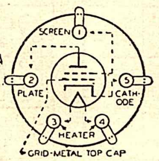


FIG. 9

24A, 35, 36

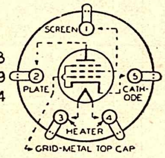


FIG. 9A

38, 39, 44

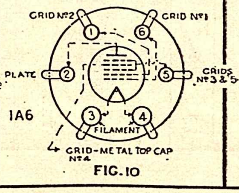


FIG. 10

1A6

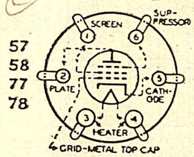


FIG 11

57, 58, 77, 78

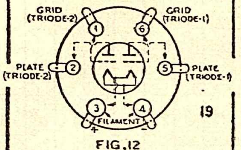


FIG. 12

19

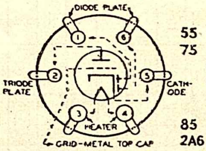


FIG. 13

55, 75, 85, 2A6

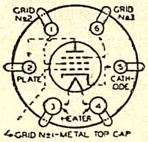


FIG. 14

89

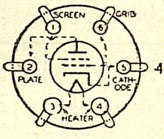


FIG. 15

48

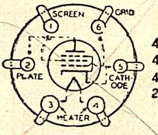


FIG. 15A

41, 42, 43, 2A5

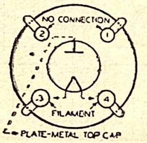


FIG. 16

866

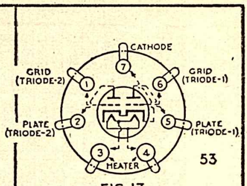


FIG. 17

53

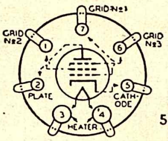


FIG. 18

59

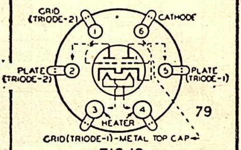


FIG. 19

79

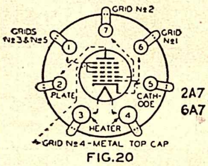


FIG. 20

2A7, 6A7

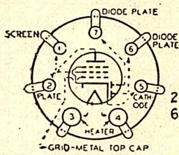


FIG. 21

2B7, 6B7

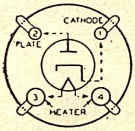


FIG. 22

1V, 12Z3

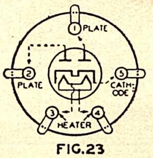


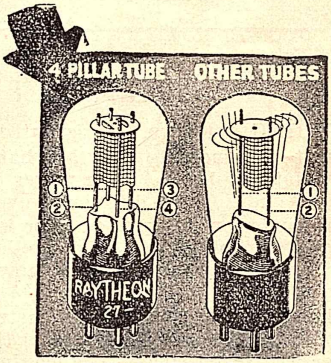
FIG. 23

84

SAFETY IN THE SKIES

4-PILLAR RADIO TUBES KEEP THESE GIANT PLANES OUT OF THE PATH OF STORMS

There's no more flying into unknown air and weather conditions. To-day, pilots receive radio weather reports every 15 minutes — **THROUGH 4-PILLAR TUBES**: "Clear, with unlimited ceiling ahead." Great air lines take no chances. Motor vibration and the jolts of landing and taxiing could easily damage fragile radio tubes and interrupt the service. That's why they depend on Raytheons—rugged 4-pillar tubes which have the strength to protect their vital accuracy. Raytheon 4-pillar tubes are used exclusively by: Transcontinental and Western Air, Inc., Western Air Express, The Transcontinental Air Transport, Inc. (The Lindbergh Line), Eastern Air Transport, Inc., and other famous lines all over the world. In your own radio receiver you want the same flawless reception. Fit Raytheons and **HEAR THE DIFFERENCE.**



Raytheon 4-Pillar Tubes are made in all styles, to fit any kind of set. They cost no more. Yet they offer surer reception, longer life, and protection against vital elements becoming unbalanced.

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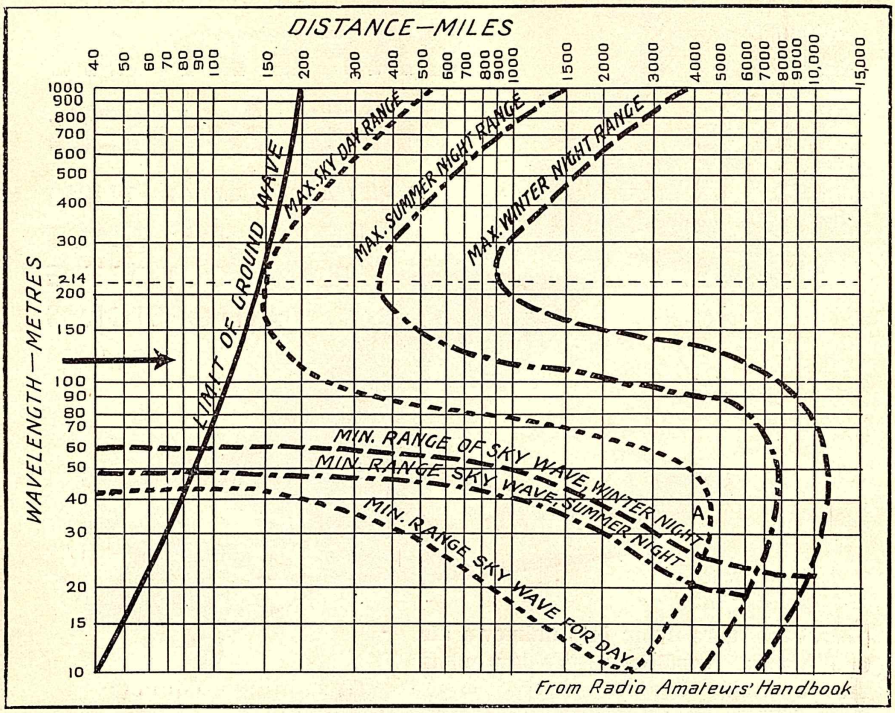

From Radio Amateurs' Handbook

AVERAGE RECEPTION CHART

ASSUMING a transmitter is putting a power of 5000 watts into the aerial, this chart is intended to show at what distance good reception may be expected under latter. Note the low carrying power of 214 metres beyond the ground wave. ordinary conditions on different wavelengths and the comparative efficiencies of the

Transmission is supposed to be in the direction of the arrow. The ground wave gives good reception at all times. Vertical lines coming between two curves, shown with the same dots and dashes, show that reception should be obtained at that distance.

Thus it is seen that 30 to 40 metres has the best daylight range (A). Reception will, of course, tend to weaken as the maximum range is approached, but a good receiver will reach beyond the maximum, according to its capabilities. Good conditions will greatly increase these figures at times.

Condensers in Series and Parallel

Separate capacities.		Combination series	parallel.
.0001 and .00025	......	.000071	.00035
.0001 and .0005	......	.000083	.0006
.0001 and .001	......	.000093	.0011
.0001 and .002	......	.000095	.0021
.0001 and .005	......	.000098	.0051
.0001 and .006	......	.000098	.0061
.00025 and .0005	......	.00016	.00075
.00025 and .001	......	.0002	.00125
.00025 and .002	......	.00022	.00225
.00025 and .005	......	.00023	.00525
.00025 and .006	......	.00024	.00625
.00035 and .005	......	.00033	.00535
.00035 and .003	......	.00036	.00335
.00035 and .0002	......	.00013	.00055
.00035 and .0001	......	.000075	.00045
.00035 and .0005	......	.00018	.00085
.0005 and .001	......	.00033	.0015
.0005 and .002	......	.0004	.0025
.0005 and .005	......	.00045	.0055
.0005 and .006	......	.00046	.0065
.001 and .002	......	.00066	.003
.001 and .005	......	.00083	.006
.001 and .006	......	.00085	.007
.002 and .005	......	.0014	.007
.002 and .006	......	.0015	.008
.005 and .006	......	.0027	.011

Section 7.

A GLOSSARY OF RADIO TERMS

A.C.—See "Alternating Current."

A.C. RECEIVERS.—Receivers which work directly from the electric mains.

ACCUMULATOR.—A chemical appliance used for storing electrical energy.

ADAPTER, GRAMOPHONE.—A device by which a pick-up may be connected to a radio set.

ADAPTER, SHORT-WAVE.—A short-wave set comprising detector and sometimes radio valves arranged ready for plugging into a broadcast set to employ the audio stages for further amplification.

AERIAL.—The wire or wires by means of which wireless waves are transmitted or received. In effect, the aerial acts as one plate of a condenser, of which the earth is the other plate, and the air between is the insulating material, or, as it is generally called, the dielectric.

AERIAL, BEVERAGE.—An aerial whose length is several times the wavelength to be received, its height being only a few feet from the ground. It may be either connected to earth or left insulated at the free end. It has marked directional properties, and gives a relatively large ratio of signal to atmospherics.

AERIAL CIRCUIT.—The aerial circuit embraces the aerial and all devices connected between the aerial and the earth, usually including a variable condenser and tuning coil.

AERIAL, INDOOR.—See "Antenna, indoor."

AERIAL, INVERTED L.—An aerial having a horizontal portion and a vertical down lead at one end.

AERIAL, FRAME.—See "Antenna Frame."

AERIAL, T.—One in which the vertical down-lead is attached to the middle of the horizontal span.

ALTERNATOR.—A dynamo for producing an electric current.

AMMETER.—An ampere meter, or instrument for measuring in amperes the current flowing in an electric circuit.

AMPERE.—The measurement of the flow of electric current, being the current that can be driven through a resistance of one ohm by a pressure of one volt. If the terminals of a single 2-volt accumulator cell are joined by 14 yards of No. 28 s.w.g. copper wire, a current of one ampere will flow in the wire; or, in other words, the resistance of such a wire is 2 ohms.

AMPERE-HOUR.—The quantity of electricity that passes through a circuit in one hour when the rate of flow is one ampere. The unit is extensively used in measurement of battery capacity.

AMPLIFICATION.—The process of magnification of signals.

AMPLIFICATION FACTOR.—The magnifying powers of the valve, obtained by dividing the number of grid bias volts necessary to reduce the output of a valve in milliamperes to 0 into the number of volts applied to the plate. It is the number of times the grid bias voltage is more effective than the plate in controlling the anode current.

AMPLIFICATION, POWER.—A term applied to the last stages of an amplifier, that have the function of supplying power, as different from "voltage" amplification, which involves merely the stepping-up of the voltage. Such an operation requires the use of special valves (power valves with a large plate current).

AMPLIFICATION, PUSH-PULL.—A system of amplification employing two similar valves per stage. The grids of the valves are led from a single secondary winding, one end to each grid, and a centre tapping is connected to the common filament circuit.

AMPLIFIER, AUDIO.—The valves and their associated apparatus used after the detector.

AMPLIFIER, DIRECT COUPLED.—A system of amplification whereby the plate of one valve is directly coupled to the plate of the next valve. What voltage is negative to the grid of this valve is, through the arrangement of resistances, positive to the preceding valve. Sometimes called the Loftin-White System.

AMPLIFIER, MAGNETIC.—Sometimes called a "bar magnet," an arrangement of a special transformer, and the essentials of a microphone.

AMPLIFIER, RADIO.—The stages preceding the detector.

ANODE.—The electrode or terminal of the output (positive) circuit of a valve.

ANTENNA.—A device by which wireless impulses are collected. An aerial is an outdoor antenna.

ANTENNA, INDOOR.—A wire or wires arranged inside a building to dispense with an outdoor aerial. It is different from the frame or loop, and works on the same principle as the outdoor one.

ANTENNA, LOOP OR FRAME.—This type of aerial is wound on a frame which may rotate, or orientate. An "earth" connection is not necessary when a loop or frame aerial is used, although in some cases it can be added with advantage. It is an enlarged grid coil. A good loop, or frame, antenna is not nearly as efficient as a good aerial.

APERIODIC.—A circuit so heavily damped as to be responsive to a wide band of frequencies and to have no sharply defined peak or optimum point, is said to be aperiodic.

ARMSTRONG CIRCUIT.—A super regenerative circuit capable of remarkable results.

ATOM.—The smallest portion into which matter may be divided and yet maintain its individuality.

AUDION.—The name first given by its inventor, Dr. Lee De Forest, to the three-electrode radio valve.

AUTOMATIC LINE-VOLTAGE CONTROL.—A device for automatically maintaining the correctness of the voltage applied to the A.C. receiving set.

AUTODYNE.—A heterodyne circuit using one valve as oscillator and mixer.

A.W.G.—American wire gauge.

BAFFLE.—A screen of non-resonant material, generally wood, used in conjunction with a loudspeaker to prevent the interaction of sound waves emanating from the front and back of the instrument.

BALANCING.—The system of neutralising the internal capacity in valves to prevent feedback into the grid circuit.

BAKELITE.—An insulating material presenting an appearance very similar to ebonite.

BALLAST TUBE.—A special valve, usually gaseous, which is installed in some power apparatus for the purpose of maintaining constant voltage irrespective of fluctuations of input or output.

BAND.—A series of radio frequencies or wavelengths set aside as channels for transmitting stations.

BANK WINDING.—A system of winding wire adopted so that adjacent turns either on each side or above or below, shall not be at a materially different potential.

BATTERY.—This term indicates a chemical instrument for generating or storing, and then releasing electrical energy.

BATTERY, "A" OR "LT."—The battery employed for heating the filaments of valves.

Battery, "B" OR "H.T."—It is employed for applying an electrical potential to the plates (or anodes) of valves.

BATTERY, "C" OR "BIAS."—Supplies a potential to the grid of a valve in order to make the valve perform its various functions at maximum efficiency and with a minimum consumption of "B" battery current.

BATTERY, PRIMARY.—A battery of cells in which the electric current is generated by chemical action as distinct from a secondary or storage battery in which an internal chemical change is wrought by the application of an external current, when the battery is said to be charged; this current is given back—or a considerable portion of it—on discharge, when the chemical change is reversed.

BATTERY, SECONDARY.—A battery of secondary cells, the most common being the lead-acid type. These cells can be recharged by electricity flowing through them in the reverse direction.

BEAT-NOTE.—The result of super-imposing one oscillatory current on another in order to set up a third frequency or beat. Used in connection with heterodyne reception. See "Heterodyne."

BORNITE.—Used as crystal detector in conjunction with zincite. Bornite is a chemical compound of iron, sulphur and copper.

BROADCAST BAND.—The band of wavelengths, generally ranging from 200 to 550 metres.

BROWNING-DRAKE.—The name applied to a special regenerative set using a slot wound primary in the regeneraformer.

BUSBAR.—Copper wire, often tinned, used in wiring the circuits of wireless sets. It is manufactured round (sectionally) and square.

BUZZER.—An instrument, which, when used in an electric current can be made to buzz.

CAPACITY.—Capacity is the ability of anything to receive and store electricity. The unit of capacity is the quantity of electricity that can be forced into a device, or body, by a pressure of one volt. It is termed a "farad."

CAPACITY, DISTRIBUTED.—Capacity between any two components of different voltages. A coil possesses distributed capacity.

CAPACITY, INTER-ELECTRODE.—The capacity resulting from the proximity of electrodes in a valve.

CAPACITY, RESIDUAL.—Refers to the small amount of capacity remaining between the fixed and moving vanes of a variable condenser when they are at minimum position Usually .000025 — .00008 in broadcast band condensers.

CARBORUNDUM.—A carborundum crystal detector has the advantage of great stability, but it is generally recommended that to obtain the best results a small 4½-volt battery and potentiometer should be used with it.

CARRIER - WAVE. — See "Continuous Waves" and "Modulation."

CATHODE.—Sometimes spelt "Kathode." The filament or source of the electron supply in a valve. (The negative electrode). In indirectly heated A.C. valves it is separate from the filament.

CATWHISKER.—A fine piece of wire, which may be of various kinds of metal, usually in the form of a spiral coil, used in conjunction with a detector crystal, upon which it rests when in operation.

CELL.—One of the units of a battery of either wet or dry variety.

CHARGER, BATTERY.—See "Rectifier."

CIRCUIT.—A collection of wireless or electrical instruments so arranged, or wired, that a current can flow from one to another without interruption.

CIRCUIT, OSCILLATORY.—A circuit of condensers and inductances in which high frequency current will surge backward and forward.

COIL.—A winding of wire.

COIL, AIR CORE.—Inductance coils wound on hollow formers. Used in the r.f. and i.f. portions of radio receivers.

COIL, ASTATIC.— Similar to a solenoid coil, but at the centre the winding direction is reversed.

COIL, BANK WOUND.—A plain cylindrical coil having two or more layers wound one over the other.

COIL, BUCKING.—Part of a winding or a separate winding on the same former as another connected or mounted in such a way that its magnetic effects oppose the magnetic effects of the main or part of the main winding.

COIL, BASKET.—A coil formed by winding wire round an odd number of pins projecting radially from a central boss. Such a coil has the appearance of certain forms of basket work.

COIL, CHOKE.—An inductance, comprising a coil of very fine wire, without any associated condenser, designed to act as a choke to prevent the flow of high frequency currents in a circuit.

COIL, HONEYCOMB.—A type of multilayer coil in which the lattice formation of the successive layers suggests the honeycomb.

COIL, IRON CORE.—A coil wound round iron, usually laminated silicon steel. Used in the audio portion of a radio receiver.

COIL, LOADING.—An additional coil to increase the wavelength.

COIL, SECONDARY.—See "Primary."

COIL, SOLENOID.—A plain coil wound on a cylindrical former.

COIL, SWINGING.—A coil, usually for reaction, that is movable on its axis, in the field of another coil.

COIL TICKLER.—A small coil carrying rectified current placed in the field of unrectified current in such a manner as to feed back energy from the second to the first circuit, and so obtain greater magnification.

CONDENSER.—A device capable of receiving and retaining electricity in its original form.

CONDENSER, BALANCING OR TRIMMING.—A small condenser, usually 11 to 15 small plates, used with ganged condensers to balance out any small differences in the coils, and so make tuning more accurate.

CONDENSER, BLOCKING.—Another name for a fixed condenser. Its purpose is to give a short path for radio or audio frequency currents, but to act as a bar to direct current.

CONDENSER, BY-PASS.—A condenser whose function it is to carry high frequency current away from portions of the circuit where it is undesirable.

CONDENSER, ELECTROLYTIC.—A condenser formed by a metal as one plate and a liquid as the other with a gas layer as electrolyte. Such condensers possess high capacity.

CONDENSER, FIXED.—Condensers whose capacity cannot be varied while the condensers are in use.

CONDENSER, GANGED.—Two or more condensers arranged so that when the dial is rotated all the condensers move together.

CONDENSER, GRID.—A small condenser, usually of about .00025 micro-farad capacity, used in the grid circuit of a valve to bring about detection.

CONDENSER, NEUTRALISING.—An adjustable condenser of small capacity used in radio frequency circuits to neutralise the internal capacity existing between the plate and grid elements of the valve or valves.

CONDENSER (STRAIGHT-LINE TYPES).—There are three main types of variable condensers. Straight-line capacity, straight-line wavelength, straight-line frequency. In **straight-line capacity** types the increase in dial reading represents a proportionate increase in the capacity of the condenser. Condensers of the **s.l. wavelength** type are such that if a graph were drawn dial-readings v. wavelength the stations would come in on a straight line. The same applies to the **s.l. frequency** types, only in this type frequency is plotted against dial-reading.

CONDENSER, THROTTLE.—A variable condenser used to control regeneration.

CONDENSER, VARIABLE.—A condenser the capacity of which can be altered while it is in operation.

CONDUCTOR.—A substance that permits of the flow of an electric current.

CONSOLE.—An ornamental combination of receiver and cabinet standing from the floor and upon its own legs.

CONTINUOUS WAVES (C.W.).—In modern radio communications, particularly for telephony, the actual signal is superimposed upon a constant stream of h.f. waves, which are themselves inaudible. In telegraphy the constant stream is interrupted by the "make and break" of the Morse key. Continuous waves are called carrier waves for broadcasting purposes.

CORE.—The iron centre of an iron-cored inductance coil or transformer is called the core.

COULOMB.—Quantity of electricity given by one ampere flowing for one second. One ampere-hour—3600 coulombs.

COUNTERPOISE.—A system of wires (usually insulated and placed directly under an aerial), which is employed as a substitute for an earth.

COUPLER, LOOSE.—A convenient form of tuning instrument in which two coils are used, energy being transferred from one to the other electro-magnetically; if very close together, they are "tight-coupled"; if far apart, "loose-coupled."

COUPLING.—A means by which energy is transferred from one circuit to another.

COUPLING, RESISTANCE CAPACITY.—A system of audio frequency amplification whereby two valves are coupled together with a condenser. The plate and grid of the valves are energised through high resistances.

COUPLING STATIC.—Static here represents condenser and refers to the transference of energy from one circuit to another by virtue of a condenser linking the two circuits.

CROSS MODULATION.—This is interference between two signals which are insufficiently separated by the tuning circuits before the R.F. amplifier. The result is that the modulation of one signal becomes impressed on the other, and we hear our music plus music from another station.

CRYSTAL.—A metal which passes electric current more readily in one direction than in the other.

CURRENT.—An electric current is a movement of negative electrons, driven by an electro-motive force.

CURRENT, ALTERNATING.—In this type of current the voltage rises from zero to its maximum value and then falls back to zero, reverses, and goes to maximum value below negative. It then goes back to zero and commences the cycle again.

CURRENT, CONTINUOUS.—Direct current.

CURRENT, DIRECT (D.C.)—Current which flows always in the same way and does not change its polarity. It remains at constant voltage.

CURRENT, EDDY.—Currents induced in a conductor by adjacent varying magnetic fields.

CURRENT, FILAMENT.—The current taken to heat the filament of a valve.

CURRENT GRID.—Internal current flowing between grid and remaining electrodes of a thermionic valve. The normal direction is a current flowing into the valve. It is infinitesimally small. If current reverses, the valve detects or distorts.

CURRENT, OSCILLATING.—Has the same characteristics as alternating current, but takes place at a radio frequency.

CURRENT, PLATE.—That taken by the plate or anode of the valve.

CYCLE.—One complete change in an alternating or oscillating current from zero through maximum positive to zero, through maximum negative, and back to zero again.

DAMPING.—Whenever energy is taken from a circuit by any cause that cause is said to introduce damping.

D.C.C.—An abbreviation for double cotton covered.

DEAD-END.—Unused portion of a coil.

DECIBELS.—These are transmission units, used to measure differences in sound levels. 10 decibels — 1 bel, and two sounds differ by 1 bel when the energy of one is the square of the energy of the other. It is common practice in wireless work to take the output from, say, a loud-speaker at some frequency and call it zero, and then calculate the output at any other frequency in terms of decibels difference.

DEMODULATION.—The opposite of modulation—synonymous with detection.

DEMAGNETISATION.—Action of depriving a magnet of its magnetism. Can be caused by heat, dropping, or running current through it in wrong direction.

DETECTION.—The process of stopping half the wave of alternating current so that the pulsations are in one direction only.

DETECTION, ANODE BEND.—Detection by using the bend in the anode current grid volts curve by the application of grid bias.

DETECTION, LEAKY GRID.—A method of detection employing a grid-leak as condenser in the grid-circuit of the detector valve.

DETECTION, LINEAR.—A detector is linear when its a.f. output is directly proportional to the r.f. input. Such detectors produce a distortion of 10 per cent. with 100 p.c. modulated signals in comparison with the 25 per cent. distortion produced by the square law detectors. Anode bend detectors are linear only on a small proportion of the operating characteristics.

DETECTION, POWER.—A detector operated at fairly high values of input voltage. The actual detection is brought about by biasing the grid.

DETECTOR.—A device, usually either a valve or crystal, for converting into unidirectional current the radio impulses received from the aerial circuit.

DETECTOR, SQUARE LAW.—Ordinary detectors operate on what is called the square law principle, that is, the a.f. output voltage is proportional to the square of the r.f. input voltage.

DETUNING.—Tuning to a frequency slightly different from that received with the object of lessening signal strength.

DIAPHRAGM.—That portion of a loudspeaker which vibrates and reproduces the sounds transmitted from a broadcast station.

DIELECTRIC.—The name given to an insulator used as the separator of plates in a condenser. The dielectric strength is a measure of the 'goodness' of the dielectric. The greater the dielectric strength the greater the capacity of the condenser, other things, such as distance apart and size of plates, being the same.

DIODE.—A thermionic valve containing two electrodes only—a plate and a filament.

DIRECTION FINDER.—A wireless receiver in which the directional properties of one or other forms of aerial are made use of to find the direction from which wireless signals are arriving.

DISTORTION.—The process by which signals are made not normal. May be pleasant or unpleasant to the ear.

D.S.C.—An abbreviation for double silk covering.

DULL EMITTER.—A valve whose filament provides adequate electron emission, although heated only to a dull red, and consuming but little current. Modern valves are "dull-emitters."

DUPLEX TELEPHONY.—Two-way wireless telephony, reception and transmission being possible at the same time by this system.

DYNAMO.—A rotary machine which generates direct current electricity.

DYNATRON.—A valve in which increase of voltage applied between plate and filament causes a decrease in plate current. The action is opposite to that found in the normal valve.

EARTH.—In a wireless set the earth acts as one plate of the condenser, of which the aerial is the other plate.

EBONITE.—A hard rubber product possessed of excellent insulating properties.

ELECTRICITY.—The cause of all electric and magnetic effects.

ETHER.—Theoretically a medium of great elasticity, presumed to pervade all space and matter.

ELECTRODE.—Commonly applied to any of the metal elements enclosed in a valve, such as the filament or control grid, grid, anode ("plate"), or screen grid.

ELECTROLYTE.—A solution in which the passage of an electric current causes chemical and electric changes. The atoms of the solution are broken up by the passage of the electricity.

ELECTRON.—The smallest quantity of electricity known to exist. Electrons revolve at high speeds round their centres, and the group is known as the atom. The substance varies according to the number and arrangement of the electrons. A stream of electrons flowing in a given direction is called an electric current.

ELECTROSTATIC VOLTMETER.—A voltmeter whose action depends on the repulsion between two plates. Its great advantage is that no current is taken by it, and so it can be applied to any circuit, and its reading is reliable.

ELECSTROSTATICS.—That branch of electricity which deals with charges when there is no flow of current.

ELIMINATOR.—A device which renders the use of A, B, or C batteries unnecessary, as it permits the required electric current to be taken from the household electric mains for operating the receiving set.

E.M.F.—Electromotive force, the unit of which is the volt. A pressure capable of forcing a current of one ampere through a resistance of one ohm. See "Ohm's Law."

EMPIRE CLOTH.—An insulating material made in the form of a yellow cloth, used for binding coils, separating turns on a transformer, etc.

EMISSION.—The stream of electrons thrown off by the heated filament of a valve.

FARAD.—The unit of electrical capacity, being the capacity of a condenser which will store one coulomb of electricity at a pressure of one volt.

FEED-BACK.—An alternative term for "reaction," or the feeding back of high-frequency current from plate to grid circuit.

FIELD STRENGTH.—The strength of the field created by a transmitter at any particular point. Expressed in millivolts per metre of receiving aerial.

FILAMENT.—The thin wire inside the valve to which the low-voltage accumulator, dry battery, or transformer is connected. Its function is to give off electrons when heated.

FILTER.—Filters are used to eliminate unwanted sounds or signals which interfere with reception. Is an essential in power supply devices, for instance, to smooth out pulsating currents into continuous currents necessary to supply plate and grid current for receivers.

FILTER, BAND-PASS.—A filter placed between the aerial and the grid of the first valve, whose function it is to exclude all unwanted signals.

FLUX DENSITY.—Around a magnet or a conductor carrying electric current the ether is strained in magnetic lines of force. The number of lines passing through a given area is referred to as the flux density.

FREQUENCY.—In alternating currents the number of complete cycles or reversals of current per second. Thus, we speak of a 50-cycle current as one which has fifty complete reversals per second. See "Current, Alternating," and "Wavelength."

FREQUENCIES, AUDIO.—All frequencies corresponding to vibrations audible to the human ear. Frequencies between 15 and 15,000 cycles per second are termed "audio frequencies."

FREQUENCY, FUNDAMENTAL.—The lowest frequency generated by any source of sound.

FREQUENCY, RADIO.—A term applied to alternations or waves which occur at frequencies too high to be heard above 15,000 per second. Spoken of in English terms as "High Frequency."

FREQUENCY, INTERMEDIATE.—The frequency used in superhets between the mixer and the second detector.

FUSE.—A device in series in a circuit which burns out when a certain current is reached.

GALENA.—A type of crystal (sulphide of lead) usually used in conjunction with a "catwhisker."

GANGING.—The arranging of several condensers on the same spindle.

GENERATOR.—A machine for converting mechanical energy into electrical energy.

GRID.—A zig-zag or spiral of wire, or perforated metal sheet, placed between the filament and plate of a thermionic valve.

GRID BIAS.—A voltage applied to the grid of a valve. See Battery, "C."

GRID, CONTROL OR SCREENING.—A fourth element introduced into screen grid valves to reduce the space charge and increase amplification.

GRID CIRCUIT.—The circuit which externally connects the filament and grid of a valve.

GRID LEAK.—A high resistance (.1-10 megohms) connected between the grid of a valve and the battery. Placed in shunt across the grid condenser it provides a path or leak whereby the electrons which collect on the grid may return to the filament.

GRID, PRIMING.—A fifth element, used in pentode valves. It is connected to the filament.

H.T.—English abbreviation for high tension battery. "B" battery.

HARMONICS.—Are those overtones whose frequencies are simple multiples of that of the fundamental. Thus the second harmonic of middle C (256 cycles) is 512, the third 1024, and so on.

HAND-CAPACITY.—An effect which interferes with the tuning of a receiving set, created by the proximity of the hand to a variable tuning condenser.

HEAVISIDE LAYER.—An upper layer of atmosphere (60 to 200 miles above the earth) which is presumed to affect the transmission and reception of radio by acting as a reflecting or absorbing screen.

HENRY.—The unit of self-inductance, being that inductance which will so retard any change in the value of a current that it takes one second for one volt to raise the current in a circuit by one ampere. In tuning circuits the henry is too big, and measurements are usually reckoned in terms of milli or micro-henries.

HERTZ.—Unit used in speaking of radio transmission, being a cycle a second.

HERTZIAN WAVES. — Electromagnetic waves by which all wireless signalling is accomplished.

HETERODYNE.—When currents of different frequencies flow in the same circuit they produce a frequency which is equal either to their sum or to their difference. When this happens the frequencies are said to be heterodyne.

HORSE POWER.—The unit of mechanical power, equal to 33,000 foot pounds per minute.

HUM-BUCKING COIL.—This is a coil in series with the speech coil of a moving-coil speaker, but wound on the core near the field coil. Its purpose is to stop hum when the field is excited by rectified A.C.

HYDROMETER.—A device for testing the specific gravity and conditions of "wet" A or B batteries.

IMPEDANCE.—The total opposition offered by a circuit, or piece of apparatus, to a varying or alternating current, being made up of the combined effects of resistance and reactance expressed in ohms and dependent for value on the frequency being received.

INDUCTANCE.—Any change in current will cause an induced voltage in its or a neighbouring circuit. The property of a circuit which enables it to exercise this power is called inductance. It is measured in henrys.

INDUCTION.—The action by which an electric force is produced in a circuit because of its relationship to an electric field. Before induction can take place, either the voltage must fluctuate or the inducing body, usually a coil, must move in the field.

INSULATOR.—A substance of high resistance used to prevent the flow of an electric current.

ION.—A gaseous atom having a surplus or deficiency of electrons, the former being called a negative ion and the latter a positive ion.

IONISATION.—The liberation of charged particles of gas, known as ions, due to the liberation of electrons from the atoms of the gas, generally the result of collisions between the gas atoms and high-speed electrons.

JACK.—A device with springs to simplify connections.

JAMMING.—Interference in the reception of signals caused by signals from other transmitters.

JAR.—The British Admiralty unit of capacity, being 1/900, or .0011 of a microfarad.

JUMBLE WOUND.—Any unsystematic method of winding a coil.

KEY.—A switch by means of which telegraphic messages in Morse are sent.

KILOCYCLE.—1000 cycles.

KILOWATT (K.W.)—1000 watts. or 1 1-3 horse-power; 746 watts being equal to 1 h.p.

KNIFE-SWITCH.—A common type of switch wherein the moving arms are thin blades of copper, which make contact by pressing between sprung pieces of the same metal.

LAMINATIONS.—Thin sheets of metal used to form the core of a transformer.

LEYDEN JAR.—The original condenser, consisting of a glass jar coated inside and out with metal foil. It was invented at the University of Leyden.

LIGHTNING ARRESTER.—A device with a very small spark-gap frequently connected between the lead-in and earth wires of the receiver, so that if the aerial is struck by lightning the discharge will jump across the gap and not flow through the circuit and damage the apparatus.

LOAD.—Any form of resistance, inductance or impedance in a circuit is called a load.

LOUDSPEAKER, BALANCED ARMATURE.—Usually called a "cone" speaker. Around an armature balanced between two strong magnets is a coil of wire connected with the set. The impulses from this magnetise the armature, which is attracted to or repelled from the permanent magnets.

LOEWE VALVE.—A multiple valve wherein several valve electrodes and their couplings are included in one evacuated glass bulb.

LOUDSPEAKER, CONDENSER.—A type of speaker which depends upon attraction and repulsion of two-plates for its movement.

LOUDSPEAKER HORN.—There are two permanent magnets around which is wound the coil in connection with the set. The current affecting the magnets attracts or repels a thin metal diaphragm which causes the air to pulsate.

LOUDSPEAKER, INDUCTOR DYNAMIC.—A speaker between the moving coil and the balanced armature in principle. The coil connected with the set is wound round the permanent magnet and an armature is suspended between them. To this is attached the cone.

LOUDSPEAKER, MOVING COIL.—A type of loudspeaker in which a coil of fine wire is wound on a collar of light insulating material and suspended in a strong magnetic field. The alternating speech impulses cause the collar to move to and fro between the magnets. The cone is attached to the collar.

LOW TENSION or L.T.—"A" Battery.

MAGNETIC FIELD.—The space surrounding a magnet pervaded by lines of magnetic force.

MAINS UNIT.—An Eliminator.

MEG.—A prefix meaning a million.

METRE.—39.37 inches.

MHO.—American unit equivalent of conductance (opposite of resistance) measured by dividing the amplification factor by the impedance. Usually expressed in micromhos (1/1,000,000mho.). To calculate conductance in m.mhos multiply amplification factor by 1,000,000 and divide by impedance.

MICA.—An insulating mineral commonly used for radio purposes in the component parts of fixed condensers.

MICRO.—A prefix meaning a millionth part.

MICROPHONE.—A device for transforming sound waves into electric waves.

MILLER EFFECT.—An effect in a detector valve whereby energy is fed back through the anode-grid capacity. This interferes with the efficiency of the detection.

MILLI.—One-thousandth part.

MODULATION.—The impression of sound waves on the carrier.

MORSE-CODE.—The system of dots and dashes by means of which international telegraphic communication is carried out.

MOTORBOATING.—A regular put-putting noise in the speaker, due usually to some form of audio instability.

MU.—Name of a Greek letter used to denote amplification factor.

NEON LAMP.—A glass bulb containing two metal electrodes and filled with neon gas at a low pressure. When a sufficiently high potential difference is applied across the electrodes, the negative electrode glows owing to a discharge taking place through the gas.

NEUTRODYNE.—A receiver employing neutralising condensers, and not using regeneration.

NON-INDUCTIVE CONDENSER. — Most condensers of high capacity are made by winding two layers of metal, separated by insulator, in a roll—like a roll of bandage. The result is that the coil of metal has considerable inductive effect, which may affect a circuit very much. To avoid this a special form of winding is sometimes employed, and the condenser is then guaranteed as 'non-inductive.'

NON-INDUCTIVE RESISTANCE.—This is usually made of composition. The ordinary wire-wound resistor, being a coil, has considerable inductance, and we often need to avoid this.

OHM.—The unit of electric resistance. A column of mercury having a weight of 14.4521 grams when formed into a thread of 106.3 cms. long and maintained at 0 degrees C., has a resistance of 1 ohm.

OHM'S LAW.—According to Ohm's Law: Current (I) (in amperes) equals voltage (E) divided by resistance (R) (in ohms); resistance (in ohms) equals voltage divided by current (in amperes); voltage equals current (in amperes) multiplied by resistance (in ohms). In symbols: I equals E/R, E equals RI, R equals E/I.

OSCILLATOR.—Any device which will produce or emit oscillating current.

PARALLEL.—Where current from a battery divides between two or more conductors and the whole current does not flow through each in turn, the connection is said to be shunt or parallel in contradistinction to the second connection, which would be said to be in series.

PAXOLIN.—A pressed board made of compressed layers of paper soaked in a bakelite mixture. It makes a board of excellent insulating quality, and is also light and strong.

PEAK.—A point in tuning at a given frequency where the most accurate setting, and consequently best results, are obtained.

PENTODE.—A valve with five electrodes.

PERIKON.—A form of crystal detection in which contact is made between two crystals, such as zincite and bornite.

PERMALLOY.—An alloy consisting of iron and nickel in various proportions, having a high magnetic permeability.

PHASE.—A fraction of a cycle measured in degrees.

PICK-UP.—A device for attaching to a gramophone to enable the signals from the record to be amplified by the radio set.

PLATE.—Anode of the valve.

PLUG.—A device used in conjunction with a jack to allow of easy connection and disconnection between two portions of an electric circuit.

POSITIVE.—Electrical pressure greater than earth.

POTENTIAL.—A relative quality, best explained by an example: Thus, the positive terminal of a 6-volt accumulator has a positive potential of 6 volts (or 6v. plus) relatively to the negative terminal—which is, of course, 6 volts negative (or 6v. minus) in regard to the positive terminal.

POTENTIOMETER.—An instrument used determining potential difference. Usually applied to a compact device for varying the potential applied to different parts of wireless circuits.

POWER PACK.—A device including a transformer, rectifier, smoothing condensers, and resistances to do away with batteries.

PROTON.—A positive particle of electricity. It is now supposed that each atom of matter consists of a nucleus formed by a proton or protons and electrons, surrounded by a ring of satellite electrons. The nature of the matter is determined by the number of these particles and their arrangement.

RADIATION.—The action by which waves are sent out from their source.

REACTANCE.—The opposition offered to the flow of varying current by a condenser (capacity reactance) or by an inductance (inductive reactance).

REACTION.—By coupling either electro-magnetically or electro-statically, the plate circuit of a valve back to the grid circuit of the same of a preceding valve, a portion of the amplified energy in the plate circuit is fed back into the grid circuit, from which it again passes through the valve and is re-amplified.

RECEIVER, RADIO.—A combination of parts which makes possible the reception of radio waves.

RECTIFIER, BULB.—In battery charging appliances, a bulb rectifier consisting of a filament and a plate in a glass bulb having a low vacuum or special gas, is used for the purpose of rectification.

RECTIFIER, COPPER OXIDE.—Plates of metal having oxidised surfaces are clamped together and have the effect of rectifying alternating currents.

RECTIFIER, ELECTROLYTIC.—A chemical solution contained in a glass jar with two electrodes usually of aluminium and carbon, the action of which is to rectify.

RECTIFIER, VALVE.—Usually a two-electrode valve which, when suitably connected, has the property of rectification.

REFLEX.—Type of circuit in which amplification is repeated through one or more valves. Thus a valve may perform the duty of an amplifier of radio as well as audio-frequencies simultaneously. This is also known as dual amplification.

REGENERATION.—See reaction.

REGENERAFORMER.—An air core transformer with a reaction winding to allow R.F. current from the detector plate to be fed back into the grid circuit.

RELAY.—A device whereby a current from one circuit switches in another circuit.

REMOTE CONTROL.—A method of control whereby we can switch a set on or off from another room. It involves the use of a relay actuated by a dry battery.

RESISTOR.—A device to break down voltage when current is flowing.

RESISTANCE, R.F.—The resistance which a conducting path offers to radio-frequency currents.

RESONANCE.—If two tuned circuits are both adjusted to the same wavelength they are said to be in resonance.

RESONANCE.—The name given to the behaviour of an electrical circuit when arranged to have a maximum response to an applied E.M.F. When we tune in a signal we really arrange the tuning circuit to be in resonance with the applied signal. Resonance in a loud-speaker means an exaggerated response to a certain frequency. If a loud-speaker has outstanding resonances at certain frequencies the result is very distressing distortion.

R.F.C.—A choke which offers considerable impedance to radio frequency currents.

RHEOSTAT.—A variable resistance used for the purpose of controlling the flow of current.

ROOT-MEAN-SQUARE.—This is a term applied to alternating current or voltage. It means the value of current which would give the same heating effect as a direct current of that value. It is the value usually taken for A.C., the maximum reached in a half-cycle being called the 'peak' value, and is 1.4 times as big as the R.M.S. value. It we are told that our A.C. supply is at a pressure of 200 volts we understand that this is the root-mean-square value.

S.C.C.—Single-cotton-covered.

SELENIUM CELL.—A primary cell whose resistance varies according to the intensity of the light falling upon it.

SERIES CONNECTION.—Method of connecting batteries, etc., by joining positive of one to negative of another. The voltage is equal to the sum of the voltage of each individual cell.

SELECTIVITY.—The ability of a receiver to distinguish between two adjacent frequencies.

SHIELDING (or screening).—In order to retain a certain degree of compactness in a receiving set it is often necessary to place certain components closer together than is theoretically desirable, and in order to minimise possible interaction, the components (such as low-frequency transformers) are shrouded (or shielded) with soft iron, lead, tin foil, or copper foil.

SHORT CIRCUIT.—The name given to the shunting of an electric source by a circuit of such low resistance that too great a current is taken. It is a comparative term, for a resistance of 20 ohms would be a short circuit on 230-volt a.c. mains, and the fuse would 'blow,' whereas the same resistance applied to a pocket-lamp battery would not be a short circuit, only about one-fifth of an amp. resulting. A condenser will act as a short circuit to radio-frequency currents. If we shunt our loud-speaker with a fixed condenser of 2 mfd. cap-

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acity most of the current will be 'shorted' through the condenser.

SHORT-WAVE.—The term is usually applied to wavelengths under 100 metres (i.e., frequencies of more than 3000 k.c. per second). The term "ultra short" is used to designate the wave-band below 12 metres.

SHUNT.—Parallel.

SIDE-BAND SPLASH.—The name given to a peculiar form of interference, which occurs when we hear speech from an unwanted programme interfering with the desired one with peculiar grasshopper noises, tsit, tsit.

SMOOTHING CIRCUIT.—A circuit consisting of a number of inductances and condensers used for eliminating the ripple or pulsating component of an uni-directional current, such as that obtained from a rectifier.

SKIN EFFECT.—The tendency for R.F. current to flow on the outside instead of through a conductor.

S.L.F.—These letters mean 'straight-line frequency,' and refer to that design of variable condenser vanes whereby the number of degrees through which the vanes are turned is proportional to the frequency of the circuit thus tuned.

S.L.W.—These letters mean 'straight-line wave-length,' and refer to that design of variable condenser vanes whereby the number of degrees through which the vanes are turned is proportional to the wave-length of the circuit thus tuned. The name 'square law' is also applied to the same design.

SOLENOID.—A type of electro-magnet in which the armature is attracted into the central space in the interior of the windings, when current is passed through the coil. Applied to "coil" means one wound on a cylindrical former.

SPAGHETTI.—An insulated sleeving for the purpose of covering busbar wire.

STAGE GAIN.—The number which shows the magnification obtained from a valve and its associated coupling.

STALLOY.—A soft iron admirably suited for the core of audio frequency tronsformers and chokes.

SULPHATING.—The name given to the white deposit on the plates of the accumulators when they have been left uncharged for some time. Bad sulphating is incurable.

SUPER-REGENERATION.—The application of reaction to such a degree that oscillation would take place, but is stopped by a special arrangement of circuit. The Armstrong and Flewelling circuits are special instances of super-regeneration. Great sensitiveness is thus obtained, but skill in manipulation is necessary.

TELEVISION.—Transmission and reception of images of moving objects by radio.

TENSION.—Voltage.

THERMAL DELAY SWITCH.—A switch which depends on heating. It is usually arranged in an all-mains set so that the valve-heaters shall get hot before the high-tension volts are switched on. This avoids damage to the valves.

THERMIONIC VALVE OR TUBE.—The name which is sometimes used for a wireless valve, and is, of course, the correct name.

THRESHOLD HOWL.—This is the sound produced when we use reaction, but before the set goes into oscillation. It is usually due to feed back of high-frequency currents from the audio side to the tuning circuits, or even the aerial. A special filter has often to be fitted to prevent this.

TICKLER.—An American expression denoting a reaction coil.

TRANSFORMER.—A device for transferring A.C. from one circuit to another without a mechanical connection.

TRANSFORMER, AUDIO.—A transformer with an iron core used in audio circuits.

TRANSFORMER, AUTO.—A transformer with only one winding. The primary circuit is tapped into the secondary.

TRANSFORMER, POWER.—A transformer to step up or down the A.C. mains to supply a radio receiver.

TRANSFORMER, RADIO.—A transformer consisting of relatively few turns, with an open core, and employed in radio circuits.

TRANSIENT.—This is a sudden change in conditions, and a loud-speaker depends for its faithfulness on a fairly good response to transients in speech and music. If there is any time lag we get confusion.

TRICKLE CHARGER.—An accumulator charger which is arranged to charge at a low rate, usually ½ amp.

TRIMMER.—See "Condenser Balancing."

TRIODE.—An alternative name for the three-electrode thermionic valve.

TUBE.—The American term for "valve."

TUNED ANODE.—A form of high-frequency intervalve couplng in which a single-tuned coil is used.

VALVE.—A tube exhausted of air or filled with gas containing conductive bodies—electrodes; it thus has the power of rectifying and amplifying electric currents.

VARIOMETER.—Similar to vario-coupler, but the two coils are joined in series, and the total inductance is varied. A variometer gives as smooth a method of varying inductance as does a variable condenser that of capacity.

VERNIER.—This is really a special form of sliding scale which in conjunction with a fixed scale enables us to get very accurate readings of lengths and angles. In radio the name has been adopted for those end vanes to some variable condensers by means of which we can make very fine adjustments.

VERY SHORT WAVES.—The official name for ultra-short waves.

VOLT.—The unit of electrical pressure. Defined as the pressure needed to drive one amp. through one ohm.

WATT.—The electrical unit of power, equals 1 volt multiplied by 1 ampere; 746 watts equals 1 horse-power; 1000 watts equals 1 kilowatt.

WAVE.—A disturbance of some elastic substance having a regular frequency.

WAVE-TRAP.—A device to eliminate interference from a local station.

WAVE-METER.—A calibrated tuned circuit which radiates, either by means of a buzzer or an oscillating valve (known respectively as a buzzer wave-meter and heterodyne wave-meter) oscillations of a known frequency or wave-length.

WET BATTERY.—This is any cell or combination of cells which uses liquid electrolyte.

WOOD'S METAL.—An alloy which melts at very low temperature, and is therefore useful for the home constructor when fixing a crystal into a metal cup.

WUNDERLICH VALVE.—A special valve with one plate and two interwoven grids, as well as cathode and heater, invented in America. It is specially designed for perfect detection, and also is very useful for automatic volume control.

STATION LOG

Call	Location	Frequency	Metres	Dial

STATION LOG

Call	Location	Frequency	Metres	Dial

STATION LOG

Call	Location	Frequency	Metres	Dial

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NOTES

NOTES

NOTES

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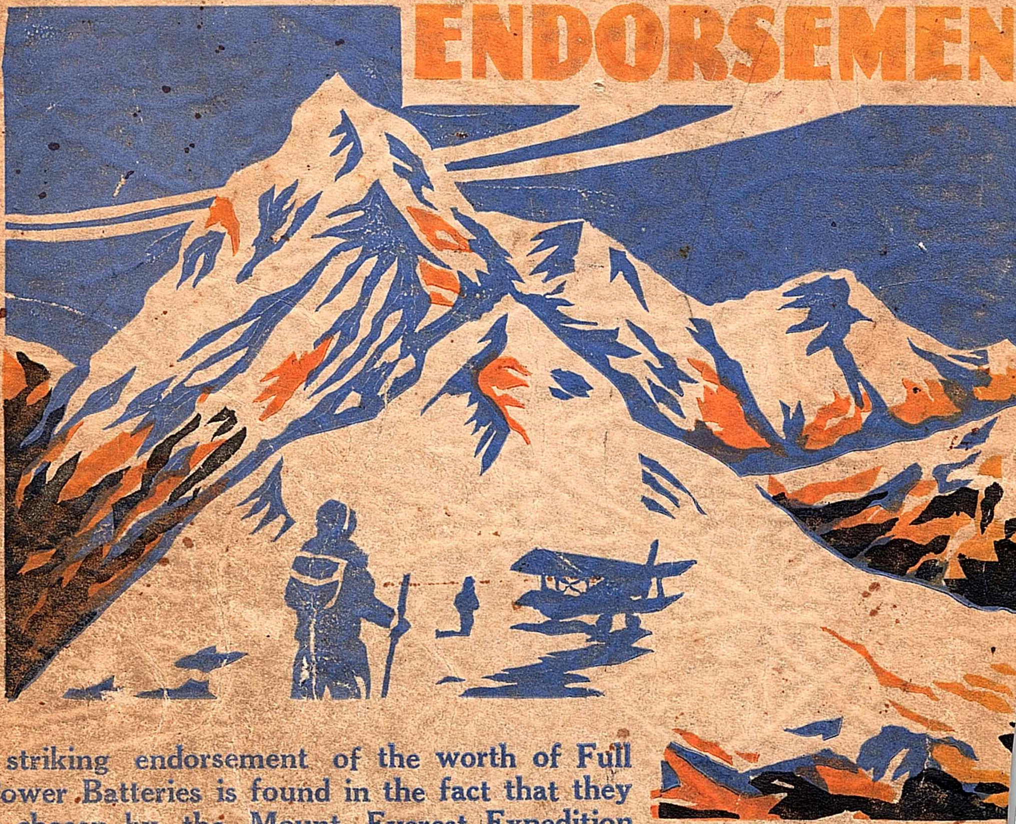

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